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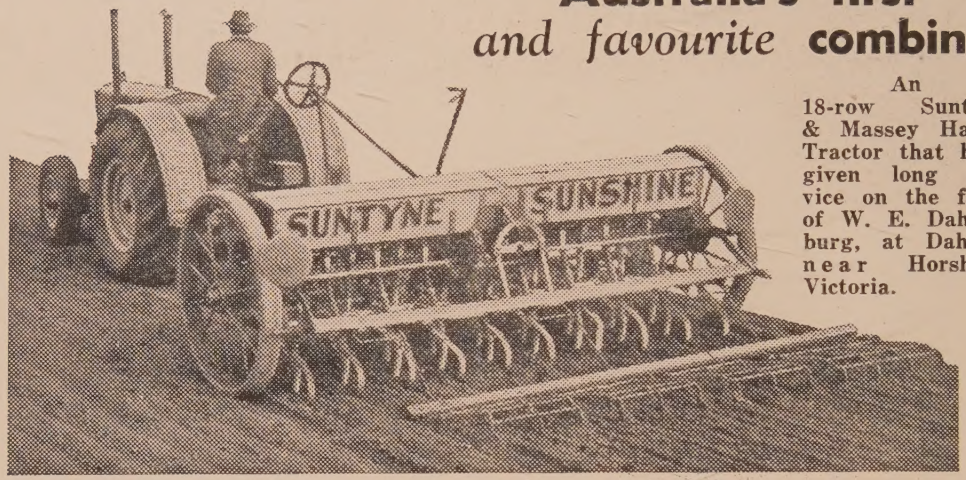

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Vol. 15 **No. 1**

MARCH, 1949

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PRESIDENTIAL ADDRESS

TWENTY YEARS OF DISEASE CONTROL

By A. F. BELL

Plant disease annually takes toll of economic crop plants on a stupendous scale and, down through the ages, the disastrous effects of epiphytotics have caused famines and decimation of population. These visitations were regarded as of supernatural origin, or as expressions of displeasure on the part of whatever Gods may be, and it is only during the past century that the knowledge of causation of disease has been developed. The beginning of effective disease control dates only from the accidental discovery of Bordeaux mixture in 1882 and, for all practical purposes, it may be said that applied plant pathology is a product of the 20th century.

In Australia, sugar cane has been grown commercially from Port Macquarie (Lat. 32° S.) in New South Wales, to the Bloomfield River (Lat. 16° S.) in North Queensland. Over this extent of 16 degrees of latitude may be found the climatic equivalent of every area in which sugar cane is grown commercially throughout the world. As a natural result cane growers in Australia had imported cane varieties from virtually every country in the world before the nature of plant disease was appreciated and the necessity for quarantine measures realised. Inevitably, under these circumstances they also imported the associated diseases of sugar cane and Australia is in the unenviable position of having practically all the recognised major diseases of cane.

Training of Staff

The declining price of sugar in the early nineteen twenties, and the consequent need for increased yields and improved efficiency, prompted the Queensland Sugar Industry to set about the enlargement and improvement of its technical services. In accordance with these plans three selected graduates of Queensland University were sent abroad in 1924 and spent some four years in overseas educational institutions and in sugar-producing countries.

Upon the accession of this staff it became evident that the disease problem was one of extreme importance and required urgent and concentrated attention. In the course of the next two decades an effective disease control system was initiated and developed. Commencing as Pathologist in 1928, I was very closely associated with this work until I relinquished the position of Director of Sugar Experiment Stations in 1947. The position as we found it, and the system of control which developed, had many special features of interest.

Many Producers

Reference has already been made to the extensive collection of major diseases of which Australia was the unfortunate possessor. Moreover, the crop was pro-

(*Presidential Address delivered at the Thirteenth General Meeting of the Australian Institute of Agricultural Science, on 19th January,* 1949.)

duced, not by a few plantations, but by about 8,000 farmers; in many countries a disease control policy could have been determined by discussion with about fifty plantation managers, but under our conditions this sort of action was obviously only a fond memory. Sugar cane is a tall bulky crop, grown in large fields, with a low value per plant; consequently the usual plant pathological techniques of spraying and dusting were out of the question. It is not propagated from seed, and in planting some one and a half to two tons of cuttings are used per acre; ordinary seed treatments are therefore out of the question. Indeed, almost everything we had learned seemed to be out of the question!

A great deal was known of the characteristics of a number of diseases as a result of the excellent work of Mr. D. S. North, for many years Plant Pathologist to the Colonial Sugar Refining Company in Australia and Fiji. The distribution of diseases within Queensland was also accurately known as the result of extensive field surveys carried out during the years 1924-7.

A decision was made to attack the most serious diseases first by the development of resistant varieties; urgency here applied particularly to the bacterial disease "gumming" which actually threatened the continuance of the industry in southern Queensland. This involved, initially, a considerable amount of research and experimentation in order to evolve satisfactory disease resistance trials. The method of inoculation employed, and the conditions under which resistance trials are conducted, are of the greatest importance since the object of the resistance trial is to determine what will be the reaction of new varieties under field conditions, while obtaining this information in the shortest possible time. Conditions must be such as to obtain a valid comparison between the resistance of the unknown variety with that of standard varieties whose performance in the field is established by years of observation.

Development of Techniques

Eventually, suitable techniques were evolved, often combining natural and artificial methods of inoculation. For example, in gumming disease trials the test varieties were finaly planted between "guard rows" of known susceptible but tolerant varieties; the latter were inoculated artificially and then served to provide a continuous and fairly concentrated source of infection. To avoid wrongful conclusions from the use of a single strain of the causal organism the inoculum was drawn from several sources and the guard rows were comprised of a number of varieties to avoid selective filtering of strains (if any).

In furtherance of this line of attack varieties of suitable parentage were imported from abroad in increased numbers, while the seedling raising programme was expanded to give 20,000 new varieties annually. By these means a selection of suitable varieties of known resistance was built up and by 1933 it could be said that the tide in the fight had turned.

In the meantime attention had been given to the group of diseases in which the causal agents are omnipresent, being able to persist in the soil, in crop residues, or in alternative hosts. In some cases the resistant variety technique was applied but for the most part they consisted of diseases which were serious only under particular conditions and losses could be minimised or even eliminated by adjustment of cultural practices. Such diseases included red stripe, red rot, spindle top, and some root troubles, and the remedial measures included adjustments in time of planting, reduction in the number of plants per acre, decreasing the proportion of early or mid-season maturing varieties, adjustment of fertilizer practices, cleaner cultivation, and so on.

An efficient quarantine service for the importation and transfer of varieties was also established. It is true that we already had most diseases of any note but, arising particularly from the work on wheat rust, it was appreciated that any parasite may include strains of varying and selective pathogenicity. It was certain that we could not have all possible strains of pathogens, and quarantine of foreign varieties was an obvious safeguard.

Problems facing the Industry

At this stage it seemed that we were approaching the limits of what could be done by orthodox plant pathology methods, but we were far from satisfied with this as an ultimate attainment. Promlems which worried us were:—

1. The use of highly resistant varieties to control disease had to be continued so long as disease was present; consequently many otherwise excellent varieties were discarded because they lacked a high standard of resistance. On the other hand, if the disease were eradicated the required standards of varietal resistance could be lowered.

2. Some varieties acted as carriers of disease, without suffering much loss, and the continued cultivation of these in odd corners ensured the maintenance of a source of infection. The history of disease outbreaks seemed to follow a constant pattern: disease outbreak—slow and painful substitution of resistant varieties —the introduction of a new promising variety which was not resistant—the rapid spread of this variety—and its ultimate infection from an odd planting of an old susceptible variety.

3. Although certain important easily recognised diseases could be controlled by inspection and digging out of diseased stools, many farmers "never got round to it."

4. Diseases were not present in every district and there was ever present the danger of a farmer taking diseased cane from one district to another where the chief varieties were susceptible to that disease. It is true that we had district quarantines but it was almost impossible ever to prove that a particular cane had come in from elsewhere.

5. Some farmers, with the bower-bird instinct, were prone to collect varieties from other districts and even to take newly-introduced varieties or seedlings from the experiment stations.

6. The system of field inspections was inadequate.

Legislative Control

It was obvious that the solution of most of these problems lay in a very much stricter legislative control of varieties and the transfer of cane, and the decentralisation of disease control activities.

Happily, the then Minister for Agriculture, the Hon. F. W. Bulcock (now Director-General of Agriculture), was a man of initiative and courage, and he was well supported by the Advisory Board of the Bureau of Sugar Experiment Stations. It may be interpolated here that the greater part of the finance necessary to maintain the Bureau is obtained by direct levy on millers and growers, and policy and budgets are determined on the advice of an Advisory Board consisting of two growers, two millers, and two Government nominees. No doubt such a set-up militates against the development of any oppressive bureaucracy!

The new legislation adopted in 1938 turned a number of new furrows, but it is gratifying to be able to say that it was immediately well accepted by the industry as a whole and it is doubtful whether a single voice would now be raised in opposition. Certainly there has never been any move to bring about any amendment of the Act.

In the terms of the Act the Director of Sugar Experiment Stations issues an annual list of approved varieties for each mill area and no person in the sugar

areas may plant any cane which is not approved for planting; at the same time the miller is prohibited from accepting cane of a non-approved variety. Very substantial penalties are provided for a breach of this section of the Act, including the destruction of the cane. By this means the continued cultivation of small lots of dangerous varieties by "variety Kings" has been prevented. Moreover, since the number of approved varieties has been kept down to eight or ten for each mill area the recognition of "strangers" is made easy.

Growers' Reactions

Initially some individualists felt that they should continue to plant whatever variety their fancy favoured, but this urge seems to have passed. It is true, of course, that all varieties are disapproved only on the basis of adequate field tests, and the approved variety list is not based upon empirical likes and dislikes.

Wide powers were granted the Director and his staff in ordering the destruction of diseased cane, but provision was made for the payment of compensation when it was apparent that the position had not been created by the grower's negligence.

Protection of experimental canes, such as variety trials, or new seedlings, or recently imported canes, has been ensured by the provision of a minimum penalty of £50 for unauthorised possession of an experimental cane.

Special powers have been granted in order to prevent the introduction of disease into a clean district by the unauthorised transfer of cane from one district to another. Of course the existence of a limited number of approved canes removes much of the incentive to do so, but the consequences may be very serious, and it is almost always impossible to prove that a particular plant was brought in from outside the district in question. Consequently, an avowal clause has been inserted in the Act and, if an officer reasonably suspects that a cane has been so introduced, then the onus is placed on the possessor to prove that it has not.

This sounds like a negation of the concept that a man is innocent until proved guilty. On the other hand it must be conceded that if a man has, in fact, come by the cane legally it is very easy for him to demonstrate it.

Creation of Local Boards

The decentralisation of disease control activities has been effected by the creation of local Boards. The Governor-in-Council may declare any area to be cane pest and/or disease infested and the creation of a Cane Pest and Disease Control Board follows. Such Boards are comprised of three growers' and two millers' representatives and their activities are financed by a levy on the relevant millers and growers. The amount of the levy is fixed by Order-in-Council on the advice of the Board. Seventeen such district or single-mill Boards have been created.

The Boards are charged with taking the necessary steps for the suppression of diseases and pests within their area and their powers and duties are defined on the advice of the Advisory Board. Provided they work within the limits of the charter, and render regular reports to the Director of Sugar Experiment Stations, they are otherwise autonomous. A clause provides that the Advisory Board may take over the operation of a Control Board in the case of emergency (which might be created by inefficiency) but so far there has appeared no likelihood of that being necessary.

The Boards maintain a constant inspection of the canefields in their area. Their senior men, at least, have usually been trained by the Bureau of Sugar Experiment Stations. These constant inspections provide an accurate and up-to-minute knowledge of disease distribution and enable any new outbreak of disease to be dealt with in its very early stages —the most important factor in disease control. Where diseases (such as Fiji and downy mildew) may be controlled in

the early stages by the digging out of diseased plants, the Boards' employees are empowered to do so. Where modifications of cultural practice are beneficial they pass on the few simple rules to the farmer. They also play a big part in the rapid distribution and inspection of new varieties as they become available.

This decentralised system has very important administrative advantages: Local control develops a spirit of responsibility which would not be engendered by remote centralised control; decisions can be made rapidly on the spot if necessary; the independent status enables Boards to "hire and fire" additional inspectors at short notice; and there can be developed a spirit of competition between Boards.

Present Position

Naturally, not all diseases are controlled by the measures outlined above, nor, in a few cases, has research progressed sufficiently to enable the most effective control measures to be devised. That the system has been very successful, however, is amply demonstrated by a comparison of the status of the ten most important diseases in 1928 and at the present time, summarized in the table.

Disease	Position in 1928	Position in 1948
Gumming Disease: (*Xanthomonas vasculorum*)	Present in Southern, Central and far Northern districts; extremely serious in South and actually threatened industry with extinction.	Apparently completely eradicated in all but the most Northern mill area.
Downy Mildew: (*Sclerospora sacchari*)	Scattered over the whole State and later causing serious trouble in the Burdekin, Mackay and Bundaberg districts.	Apparently eradicated in all but the Bundaberg district where an odd diseased plant is still found.
Fiji Disease (Virus)	Distributed throughout Southern Queensland.	Confined to the South and reduced to insignificant proportions in all but one mill area where special climatic conditions prevail.
Mosaic (Virus):	Distributed throughout the State and causing serious losses on river flats and in the foothill country.	Aggregate monetary losses for the whole State would probably not be £100.
Leaf Scald: (*Xanthomonas albilineans*)	Widespread in the North and scattered in Central and Southern districts.	Eliminated from the Central and Southern districts but still limiting the distribution of susceptible varieties in the North. Since infection is spread by cane knives the complete control of this disease is very difficult.

Disease	Position in 1928	Position in 1948
Red Rot: (*Physalospora tucumanensis*)	Omnipresent, and considerable losses a regular feature in the Burdekin and Central districts.	Losses now mainly confined to adverse seasons and not usually sufficient to warrant variety changes; however, red rot is eliminating Co.290 and two or three local seedlings.
Red Stripe: (*Xanthomonas rubrilineans*)	Omnipresent. Considerable losses in Northern and Central districts.	Losses greatly reduced and usually confined to adverse seasons.
Chlorotic Streak: (Virus)	Recognised as a distinct disease in 1929 and found widely distributed in Northern areas and to some extent further South. Experiments demonstrated losses could be severe in ratoons.	No very great advance in the control of this disease owing to susceptibility of the still widely-grown variety Badila. Hot water curative treatment of cuttings developed, but not widely used, due to lack of suitable apparatus on farms.
Dwarf: (Virus type)	Occurred in Mackay district on small scale.	Confined to a small area in Mackay and rare, though not extinct.
Root Disease Complex:	Substantial losses in fields of "noble" canes under unfavourable conditions.	Not now apparent with the planting of resistant types containing a proportion of wild cane ancestry.

There has, of course, been a very considerable amount of original and confirmatory research carried out in order to determine the most suitable approach to the development of control measures. This has involved, *inter alia,* a study of the aetiology and mode of transmission of several diseases, including the proof that Fiji was an insect-transmissible virus disease; studies of alternative hosts; factors underlying germination; oxidation-reduction potentials; a study of "sick" soils; and extensive mycological studies. These, however, are the means to control, not the end—which is the subject of our current discussion.

Some of the legislative provisions outlined may seem drastic but it is evident that they have assisted in achieving a very marked improvement in the sugar cane disease position. Also, it is evident that by direct association of the industry with the responsibilities of administration, there has been a minimum of friction in implementing the provisions of the Act.

Of course, all this does not mean that all the problems of cane disease control are solved. As new strains of parasites arise, and as new types of variety are evolved, so will the position continually alter. Two members of this Institute, Messrs. C. G. Hughes and D. R. Steindl, are now responsible for pathology research and disease control; it is not likely that they will lack interesting and useful employment.

ARTICLES

THE FUTURE OF THE INSTITUTE

By Professor J. R. A. McMILLAN

President of the Australian Institute of Agricultural Science

To be elected President of the Australian Institute of Agricultural Science, with a membership of eight hundred and twenty-nine, including the leading agricultural Scientists of Australia, is an honour of which I am very proud, and wish to express my thanks to all of our members. At the same time, I am very conscious of the responsibilities of the position and of the difficulties that will be encountered in discharging these, but in knowing that I have the goodwill and support of the Branches and members, I feel my tasks are much easier to face.

The Memorandum of Association lists some seventeen objects, the main one being Number 1, which states:—

"To promote the advancement of Agricultural Science and to further the interest of Agriculture in the Commonwealth of Australia."

The other objects are really subsidiary to this and more or less indicate the various things which might be done to achieve the main object. I wish to refer to four of these which were considered at the last general meeting of the Institute in Hobart, viz.:—Public recognition of the Institute, Salaries of Members, Interchange of Personnel and Extension Work.

If the Institute is to play its accepted role in Australia, it must become fully recognised by Governments and the community as the leading body on agricultural matters. We have available to us practically the whole of the trained Agricultural Scientific opinion in Australia, and, therefore, not only should we be able to give the best scientific advice on agricultural matters, but should do so and on every available occasion, bring our point of view before the public. Each of the Governments has its own corps of Agricultural Scientists who are charged with the responsibility of giving their respective Governments advice. But this does not relieve the Institute of its rightful responsibilities in such matters and of acting in a concerted manner, particularly on matters of national importance. The Institute has already been successful in this, as, for example, in the matter of Plant Quarantine, which was one of our major projects several years ago. The fact that the Institute commenced to investigate this, caused the Governments to call an official conference which adopted practically all the recommendations of the Institute. The Population Survey was another very useful piece of work. If the Institute continues to undertake projects of this nature, it will not only perform a most useful service to the country, but gradually compel the Governments and the community to grant it full recognition as an invaluable asset in the development of Australia.

The salary position of Agricultural Scientists in Australia is still far from satisfactory. Some Governments and their employing agents—the Public Service Boards—at present are not prepared to correct it. How can we be satisfied when the average Agricultural Scientist, until he reaches the age of forty, is worse

off financially than a tradesman; when the salary of the Agricultural Scientist is below that of Veterinary Scientists, Engineers, Medical men, etc. A reply from a Public Service Board stated that this was due, at present, to a scarcity of Veterinary Scientists, Engineers, etc. Does the Board, by its policy, wish to discourage people from taking up Agricultural Science and thus create a shortage in this field? Most Public Service Boards appear to have no real appreciation of the value of Agricultural Scientists or else they will not admit it. The standards of training, requirements of research and of service to the community are at least equal to those of the other professions mentioned, but because human or animal life is not directly involved—it may be indirectly—nor are bridges, power stations, railways, etc., erected, Governments and employing agents fail to accord the Agricultural Scientist the same status as those of other professions.

The achievements in these other fields are in no small measure dependent upon the achievements in Agricultural Science. We must work to have our profession recognised as at least the equivalent of those mentioned above, as this lower status retards agricultural development.

Another matter which retards progress in Agricultural Science is that there is no free interchange of personnel between Governments. There is, in fact, a so-called "Gentlemen's Agreement"—an arrangement between the several Governments concerning this. If a person who is an employee of Government "A" seeks a position with Government "B", the latter will not make the appointment until Government "A" is consulted and does not object to the proposal. This has applied even though the proposed transfer would mean a considerable strengthening of Agricultural Science in Government "B" and the officer would receive a very much enhanced salary. Apart from the fact that this is an iniquitous practice in a democratic country, it is a great handicap to the development of agriculture. Not only should this bar be removed, but Governments should, in the interest of Agriculture, actively encourage inter-Governmental transfer. The Institute cannot be satisfied until this object is achieved.

It would appear that the next major project of the Institute will be to obtain efficient Extension Services in Australia. Preliminary work has already been done and the last general meeting of the Institute decided that this matter be thoroughly investigated. The problem is not new—it has been the subject of presidential and other addresses and of branch discussions over many years, but it is considered now that some concerted Institute action is necessary. We all know that our Extension Services fall far short of requirements and that if adequate services were available, our agricultural production would be greatly increased and a much better spirit of co-operation between the farmer and the Government would prevail. Not only is increased personnel required, but the officers must be of a type specially suited to Extension Work, receive a higher level of training, both scientific and in Extension methods than at present, and must be organised into more effective units on a decentralised basis.

Everybody is, or should be, aware of the importance of Agriculture to Australia and that our national economy depends largely upon our exports of agricultural products. These must compete with the products of overseas countries in the world's markets, and such countries provide a highly trained Agricultural Science service, both research and extension, to assist their farmers. We cannot expect our farmers to compete on such unequal terms; therefore, it is essential we do everything possible to ensure that our Governments provide adequate services, and thus fulfil one of the main objects of the Institute.

MECHANIZATION OF INDIAN AGRICULTURE

By D. N. KHERDEKAR

No problem is more important for India today than her food problem. The production of food crops is given the first priority by the present National Government. Eight vast schemes for irrigation are being undertaken. Nearly all these schemes are comparable in size with the undertaking of the Tennessee Valley Authority scheme in the United States of America. The Damodar Valley project in Bengal will bring under irrigation 760,000 acres of land and produce 350,000 kilowatts of power for industry and protect the province from destructive floods. In Madras Presidency the Halcoond Project is twice as big as the T.V.A. in the acreage that will be irrigated. There are 100 million acres of land that could be brought under cultivation. New industries are being started in scores, and will expand considerably as hydro-electric power becomes available. Plans for the development of agriculture, industry, education, hospitals and social services are not only on paper as some people seem to imagine but work on them has actually started. The plans have been carefully formed by the top Indian scientists, engineers and statesmen. Obviously it would take about three to five years for the completion of some of these schemes. Many difficulties—technical and political—are bound to arise but the Nation is confident that the schemes will fulfil the purpose for which they are designed.

Economic Background

In this tremendous National regeneration and development, where does the Indian farmer stand? Let us first briefly examine the background of rural life in India. India is a nation of villages, and villages mean the predominance of agriculture. There are 700,000 villages in India. Out of the 400 million population of India, 380 million live in villages and ninety per cent. of these people are totally dependent on agriculture for their living. It is essentially subsistence farming. The average size of holding for all India is five acres, though in some rice growing provinces it is less than two acres. The average annual income of an Indian farmer is **Ten Australian Pounds,** not in cash but in the value of crop that is produced. Such is the abject poverty of millions of these farmers, that it is estimated that about 150 million people in India do not get one square meal a day. Famine is the natural outcome if the crops fail, either due to the vagaries of climate or to some other reason beyond the control of the farmers. In the 1943-44 famine in Bengal **three million people** died of starvation.

Indian farmers produce all types of crops, vegetables and fruits that are grown in the world. Rice is grown on ninety million acres, millet on sixty million acres, wheat on thirty million acres, and vegetables and fruits are grown according to suitability of soil and climate. Artificial fertilizers are not used in India. On these small farms bullock power is the only power that can profitably be used. Most of the implements are made of wood, with the working parts of steel. Ploughs, cultivators, harrows, seed drills, leather buckets for irrigation and bullock carts are the implements normally used on farms. Indian farmers are often charged with being conservative and superstitious in their outlook. The author thinks that both these charges are usually based on insufficient observation and are made by persons who do not know the facts or are not competent to give such an opinion.

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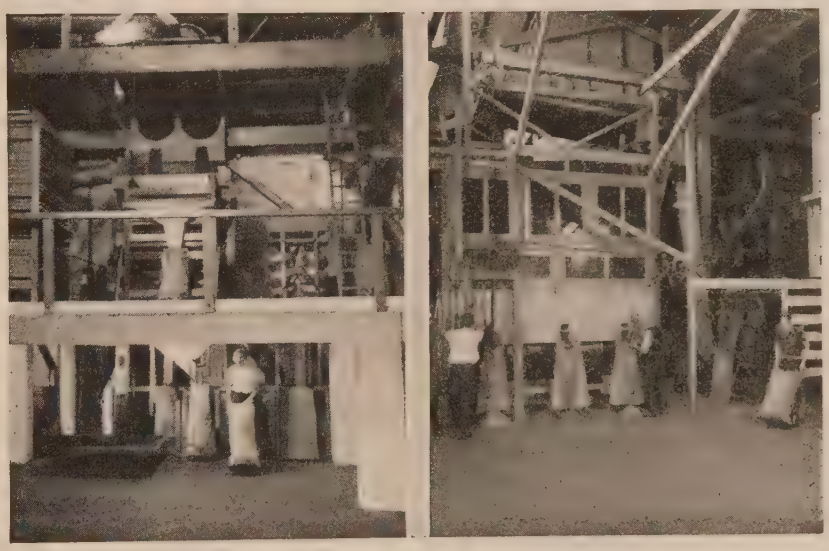

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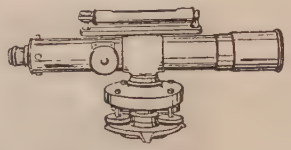

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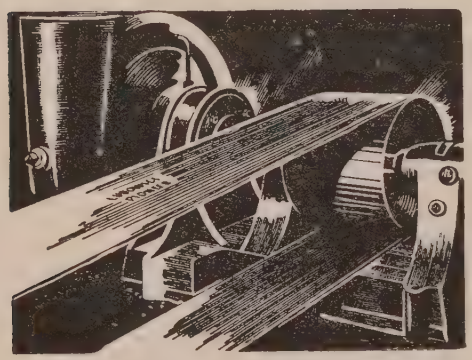

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The Indian farmer is no more conservative than any other farmer in the world. He would surely accept a machine or a process if it really is economically profitable to him. Being poor he cannot afford to make experiments or take any risk. Failure to introduce a new machine is more often due to some defect in the machine than in the outlook of the farmer. For instance, a really suitable sugar-cane crusher was introduced in the United Provinces and 85,000 of them were sold, whereas all attempts to introduce a mould-board type of plough in India have failed because turning the soil over is not necessary in the hot Indian climate. It is interesting that the Australian farmers in the Wimmera and Mallee are now recognising this same fact and are slowly abandoning the mould-board type of plough for the scarifier, grubber or skeleton mould-board.

The Place of the Cow in Indian Agriculture

The cow is economically the most important animal for India and therefore, for the last 5,000 years village folk were asked to regard it as sacred to prevent them from killing the cattle. Consider the following uses of cattle:—

1. All our agricultural tillage today is dependent on bullock power. All threshing also is done by bullocks.

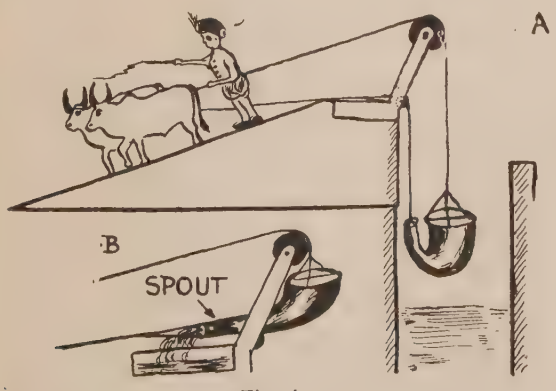

Fig. 1.
(a) Indian bucket type of waterlift.
(b) Leather bucket is emptied by straightening the spout.

2. Eighty per cent. of our transportation today is carried out by means of eight and one half million bullock carts.

3. One-third of our irrigation is from wells, and the water from them is mostly drawn out by means of leather buckets, raised by bullocks.

4. The majority of Indian people are vegetarians. Milk and milk products, therefore, form a major group in the diet, especially for children.

5. Cow-dung, fuel, manure, leather and various other products are useful by-products for the village community.

6. Cattle are very hardy animals, easy to domesticate and teach, they eat rough food and both the first cost and maintenance are much cheaper than horses. A pair of good bullocks give about one horse-power (1 H.P.) and are quite sufficient for small farms of fifteen to twenty acres. The estimated cash value of all cattle products in India is £1,221,000,000 (Aust.).

Supposing it were possible to kill all the cattle and replace the "bullock farming" by tractor farming, where is the oil to come from? India has a negligible source of oil and its military strength is not enough to get oil from other countries on fair exchange. Would it not be a catastrophe if, after completely mechanising Indian agriculture and disposing of all bullocks, the oil supply is cut off from India by another world war, the shadow of which is already looming over us? Not only, therefore, because of their usefulness but also for National safety, we must retain bullock power for our agricultural purposes. Once the imperative need for bullock-power is recognised for at least about seventy per cent. of Indian farms, one can then design suitable machinery for them.

It must not be thought from the above discussion that the present position of cattle in India is satisfactory—far from it! Most of the cattle are undernourished, but so are human beings. Attention will have to be paid to:—

a. Proper feeding of cattle both as regards fodder and concentrates.

b. Scientific breeding of cattle.

c. Designing such implements as would utilise maximum power of bullocks with comfort and ease.

d. Care of disposing of old cattle or excess cattle if any.

Such attention and care would go a long way towards building up power for India's agriculture.

Difficulties of Mechanisation

That Indian agriculture should be mechanised as early as possible is admitted by all. No reasonable person would like to adhere to the old implements if they could be profitably replaced. The solution often offered today is the revolution in agriculture on the Russian pattern, but this is certainly not applicable to Indian conditions. In the first place such a revolution would have to be on twice the Russian scale, because of the immense population dependent on agriculture. The colossal extent of mechanisation amongst the fifty million farmers, farming 300 million acres of land, taken by any standard of efficiency, equipment and personnel to perform the job, would still require, shall we say, twenty-five years. This is only a guess. Clearly it is too optimistic an estimate if consideration is given to the innumerable difficulties of poverty, illiteracy, small holdings and the precarious monsoons. To achieve this, it would require a simultaneous industrialisation of the whole country on a vast scale, in order to absorb the labour released from agriculture. To perform both these jobs is impossible, especially in the present disturbed condition of the world.

To reconcile all these important considerations there seems to be only one way out. It is the golden mean between the two extremes of conservatism and revolution. The author proposes to call it "A Government sponsored and guided evolution with the co-operation of farmers." This evolution is two-fold:—

a. By all means use the modern machinery wherever profitable.

b. Improve the existing Indian implements, where the cost of using modern machinery becomes prohibitive. By using discretion and judgment a judicious use of both Indian and modern implements can be made, the criterion of choice being the "real utility."

The modern machines may be made in India or may be imported. If made in India they would cost about one-third the cost price of either Australian or American goods. Some may be modified to suit our conditions, some again may be invented. An excellent example of such a modification is the first Indian-built tractor called "Patel" built this year by a Bombay firm. Its features are:—

i. rugged construction,

ii. high draw-bar H.P. to work hard Indian soils,

iii. bigger radiator for hot Indian Climate,

iv. Diesel engine to suit cost of fuel in India.

Improvement of Existing Implements

The improvement of Indian implements should be taken up only as an interim policy aimed at replacing them with modern machines in the future. These modern machines need not necessarily be those that are used in Australia and America, but may also be redesigned on the same pattern as the present Indian implements, if it is found that such a change is useful. To avoid any misunderstanding as to the purpose of this paper, the author would like to repeat that he is completely in favour of full mechanisa-

tion of Indian agriculture if it were possible at this moment. If by some good luck or miracle all the difficulties mentioned above were to vanish, there is no reason why modern machines should not be used for all agricultural practices in India. However, when mechanising, an implement should not be discarded simply because it is old or machines adopted, simply because they are new. This can be left to their true merits. Some of the Indian implements, even though they look crude, are not in any way inefficient or primitive as they are usually said to be. There are very many fine principles in them, developed by centuries of experience and we should make use of that experience instead of wantonly wasting it. For small farms using bullock power, Indian implements are the best; for big farms, using tractor power, modern implements are best. Each one is good in its own place.

The question may then be asked here as to why make any improvements in the Indian implements at all if they are so good? The answer is—the times are changing, e.g.,—

1. Better materials for building implements are available.

2. By absorbing more agricultural labour into the numerous new industries, there is bound to be a shortage of labour in agriculture, especially at peak periods, such as sowing, harvesting and weeding.

3. As the standard of living increases, men naturally want to work comfortably and for less hours, thereby making necessary either an improvement in the implements used or their replacement by entirely new ones. The time is ripe now to do both these things.

Formulation of a Policy for the Mechanization of Indian Agriculture

Till recently, the real welfare of the Indian farmers was completely overlooked. Therefore, complete data or information as regards the implements used by Indian farmers are not available to a research worker who intends to design suitable implements. Hence it is necessary that the future work should be based on sound foundations which can only be done by fulfilling certain prerequisite needs which are outlined below.

1. A thorough survey of all the Indian implements, tools and appliances used in all provinces should first be made. India is a sub-continent and different implements are used in different parts on account of variation in soil and climate. Perhaps an implement from one part may prove useful to some other part.

2. We should extend the scope of such a study to the implements used in all the ancient lands of Asia, Africa, America and Europe.

3. Study thoroughly all the modern machines and while doing so, be on the lookout for parts and principles that could be usefully applied to Indian implements.

4. If possible, make a study of the Patent Office publications of various

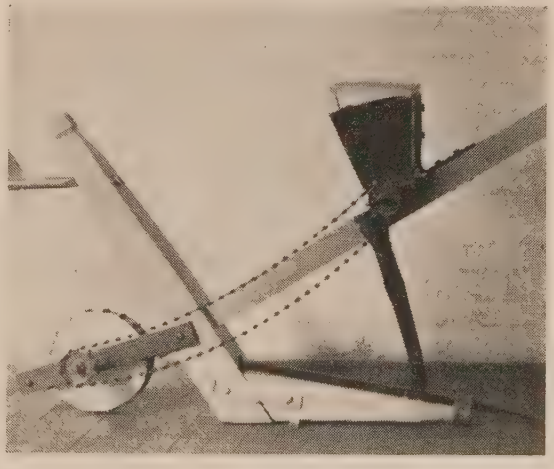

Fig. 2.
A single furrow Indian plough with Australian seed-drill attachment.

countries. This indeed is an uphill task which may take years. But such a study can be very interesting. It leads one through the mental universe of man, through mysterious mechanical ideas which some human beings have conceived and others rejected or possibly accepted. It will develop one's capacity for invention. It will show the folly of some inventors and the ingenuity of others and may provide answers to problems. Needless to say that if any idea is used, adequate financial reward should be given to the inventor concerned.

5. Compare by field trials and by scientific experiments the Indian implements and the modern machines, so that any extra yield and profit by the use of them could be correctly assessed. These scientific tests would prove once for all either good or bad points of these implements and machines. Such tests would mark an end of armchair research in Indian Agriculture.

6. Make a complete record of suggestions for improvements however trivial they may be. By regular questionnaire to the farmers make a list of their immediate needs as regards the implements. Our motto should be "to give the farmer what he needs and not what we think he should have."

When all the above data are collected, a final list of farmers' needs **in order of their importance** should be made and each one dealt with separately in detail. It would be impossible for one man to do all this singlehanded. Hence the problems should be distributed amongst a number of research workers.

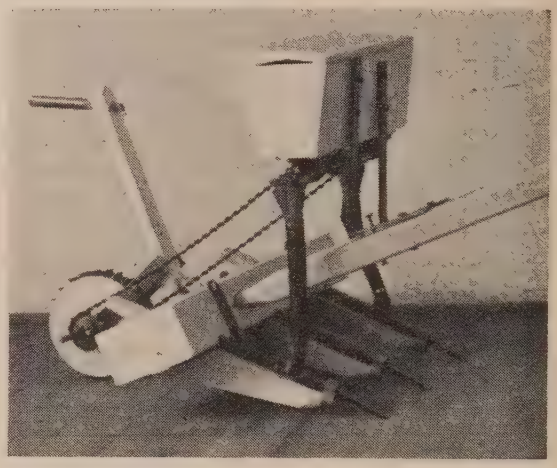

Fig. 3.
Three tyned Indian seed-drill with Australian seed-drill attachment.

Most of the above points were kept in view while the following research work on Indian implements was being done at the University of Melbourne. The Indian farms were arbitrarily divided into three groups as follows:—

Table classifying Indian Farms into groups according to acreage

Big (15%)-	Medium (15%)	Small (70%)
100 to 1000 acres.	25 to 100 acres.	1 to 25 acres.
Complete power farming. Should use all modern machinery required for 1. Big Estates 2. Private Contractors 3. Government reclamation schemes.	A combination of Power: 1. Small 3 to 4 H.P. Engine for stationary work such as irrigation, chaffcutting, milking, etc. 2. Bullock power for tillage and transportation.	Purely bullock powered. 1. Improvement in hand tools. 2. Improvement of the existing implements alone is possible.

We shall consider the small and medium farmers in the following pages, because they constitute about 85% of the total farmers. The discussion is divided into two sections:—

1. Application of modern attachments to Indian Implements.
2. Original research work or inventions.

(1) Application of Modern Attachments to Indian Implements

An attempt is made here to show how modern mechanical science can be applied to Indian implements giving them more or less a "useful New Look." The idea is to make as little change in the implements as possible and yet to incorporate in them some useful improvement. There are two main advantages gained by this method.

i. **Reduction in Cost:**—The farmer would be required to buy only an attachment because he would have his Indian implement with him.

ii. **The psychological effect** on farmers would be very good for extension work, because it is his own implement slightly modified, and he feels more inclined to take it than an entirely new one.

The actual application is done in three stages:—A seed-drill is here taken as an example, but the principles could be applied to other machines as well.

Stage A

Reduce the Size:—Say a seed-drill in Australia is 10 ft. long with 14 seed cups. We need only take 1 to 3 seed-cups and other appropriate parts for the Indian implement.

Stage B

Eliminate unnecessary parts:—How are we to decide which parts are unnecessary? If a modern machine is analysed it would consist of the following 7 elements:—

*1. *Soil working parts*:—Shares, shovels, tyres, mould-boards.

2. *Plant working parts*:—Drill-cups, knife, fan, sieves.

*3. *Body or frame.*

*4. *Seat, handle,* levers and other comforts of the operator.

5. *Machine parts*:—Gears, chains, sprockets, nuts, bolts.

*6. *Wheels, carriage.*

*7. *Beam and yoking* arrangement.

Parts indicated with an asterisk are supplied by the basic Indian implement and need not be considered. Parts in Items No. 2 and 5 are the only parts of modern machines which might be applied to Indian implements.

Stage C

Modification: These parts from No. 2 and No. 5 items are taken, they are simplified, modified and are put on the Indian implement. For example, a small hopper with one or two seed-cups is fixed on the Indian plough or drill; a small wooden wheel with chain and sprocket transmits the required power turning the seed-dropping mechanism.

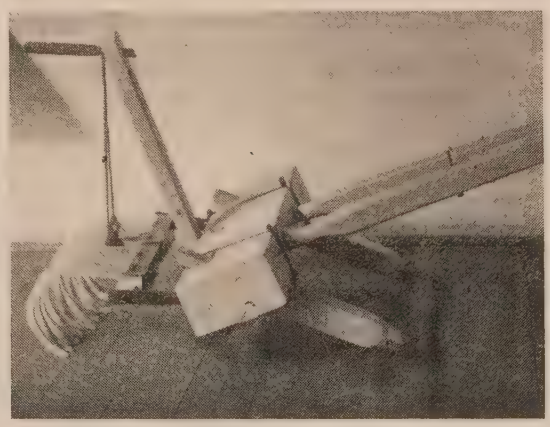

Fig. 4.
A bladed Indian harrow with weed-rake attachment.

Two other attachments can also be installed behind the bladed harrow, one for collecting the weeds cut by the blade and another for making small basins in the field to conserve rainwater in dry farming areas.

(2) Original Research Work

So far I have dealt only with the application of existing modern machinery to Indian implements. But no nation can hope to progress by merely copying others, however ingeniously it may be done. There is no real satisfaction in it. Therefore, originality must also be encouraged from the beginning for a healthy development from "within" in any industry along with the judicious assimilation of other's culture. The attempt made in that direction is that of an amateur. The author has made many mistakes but the attempts have been both interesting and instructive to him.

(a) **Internal force-feed type of seed-drill** with a device to change the seed-rate per acre. The revolving part of the device is made up of two parts:—

(i) The outer ring,

(ii) the disc with serrations on its periphery.

Both these units revolve together but the disc could be made to slide axially in or out thus exposing more or less of the face of the outer ring to the seeds, thereby changing the seed-sowing rate. The drill-cup is suitable for wheat, barley, sorghum, peas, etc. (Patent applied for.)

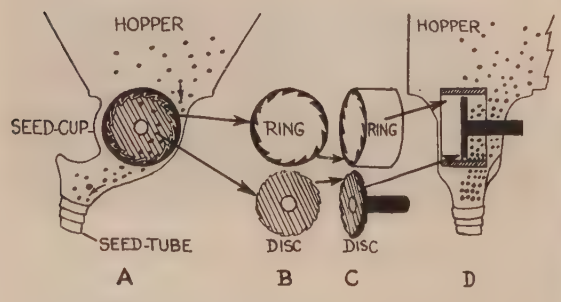

Fig. 5.

Details of a new type of seed-cup. (Patent applied for)

(a) Side view of seed-cup with hopper and seed-tubes. The disc is placed inside the ring and both of them revolve as one part, carrying the seed from the hopper to the seed-tube.

(d) Cross section from front showing how change in seed rate may be obtained by moving the disc axially in the ring.

(b) **Another type of seed-dropping mechanism.** The cone with the grooves in it is placed in a hopper. The change in seed rate is done by placing more or less of the rings which fit over the cone. If bigger seeds are to be sown the bottom ring alone is retained; if smaller seeds are to be sown 5 rings are used.

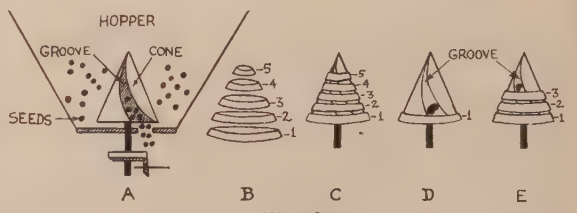

Fig. 6.

Details of another type of seed-drill:

(a) Hopper containing a grooved cone. The groove widens from top to bottom.

(b) The five different sized rings used to vary the seed-rate.

(c) to (e) Showing how seed-rate can be altered by using the different rings; similarly for different sized seeds.

(c) **Water-lift.** Such bucket type water-lifts are commonly used in India, but separate buckets are made and fixed in a steel chain. Here the buckets themselves form the chain. Lugs of one bucket are joined with the lugs of another.

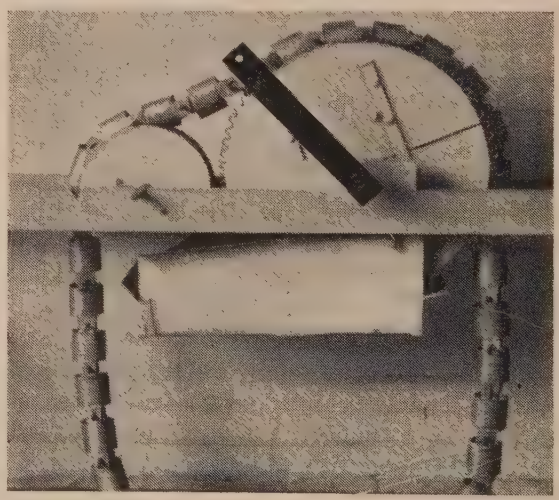

Fig. 7.

Bucket type of waterlift; the buckets are circular in shape.

(d) **A new method for manufacturing spur gears.** A strip of steel is formed into tooth shapes and fixed to the wooden wheel, which forms the body of the gear. The strip is fixed by means of screws. The gears would only be suitable for slow speed and light-weight machines. (Patent applied for.)

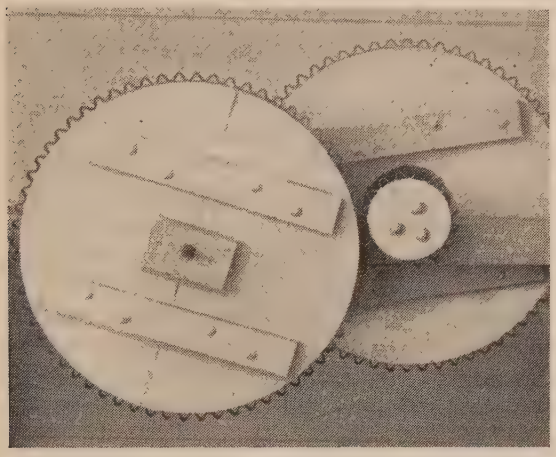

Fig. 8.
Spur-gears made by the new method. (Patent applied for).

This opens the discussion on the various aspects of the mechanisation of Indian agriculture. This is to be taken as a progress report. The work done on these machines is not complete yet and the first opportunity will be taken to test them under actual field conditions in India before recommending them to farmers. Any suggestion from readers would be greatly appreciated.

Acknowledgments

The author wishes to thank Professor S. M. Wadham, Professor and Dean of the Faculty of Agriculture, University of Melbourne, Mr. G. H. Vasey, Senior Lecturer in Agricultural Engineering, University of Melbourne, and Mr. I. Tulloh, Principal, Longerenong Agricultural College, for all the help and guidance they so readily gave him.

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PLANT GROWTH REGULATORS OR HORMONES

By C. J. MAGEE

Much interest has been aroused during recent years in a group of synthetic chemical substances which have been called plant growth regulators or plant hormones. At first these substances were merely curiosities of the botanical and chemical research laboratories, but, particularly since the war, they have gained an influence in agriculture and horticulture which has been described as revolutionary. There is little doubt that a great deal more will be heard of them as our knowledge of how to use them improves, and it can be expected that they will have a substantial influence, in a variety of ways, on the world's food supply.

Historical Survey

The first demonstration that plant growth was directed by hormones or stimuli transmitted from one part of a plant to another is credited to Charles Darwin. While studying the curvature or bending of shoots of grass towards light, Darwin showed that the effect of light was perceived by the tip of the shoot and was transmitted to the more basal portion which reacted by bending towards the light. Darwin found that if the tip of the grass shoot was removed the plant did not perceive the light and did not bend. He concluded that some influence or substance was transmitted from the tip to the lower parts of the plant. Darwin's views met with opposition from his scientific colleagues and it was not until thirty-five years later, in 1926, that Professor F. W. Went, formerly of the University of Utrecht, but now at the Californian Institute of Technology, finally settled the question.

In the meantime others, notably Fitting, Steubert, Boysen-Jensen and Paál, had contributed much valuable foundation work. Went found that the active substance in the tips of young oat plants which caused them to bend towards light, could be separated from the plants by removing the tips and placing them on gelatine or agar jelly, into which the substance diffused. He showed that the active substance was stable to heat and by a study of its diffusion rate he was able to estimate its molecular weight. More important still, Went devised a method of measuring the concentration of the substance in his extracts. His assay method, known as the Avena Coleoptile test, was a turning point in hormone research and its introduction led to a quick advance in knowledge. Much of the later work of others in isolating the stimulating substance in pure form depended for success on this accurate assay method and the test is still widely used.

Growth Promoting Substances

About the time Went succeeded in extracting the active substance from the tip of the coleoptiles of germinating oats, other investigators found that growth promoting substances occurred in such materials as malt extract, saliva, urine, maize oil, yeast and the culture media on which certain species of moulds (*Rhizopus suinus, Aspergillus niger*) had grown. The next advance came in 1931

This article is based on the notes of a popular science lecture delivered under the auspices of the Royal Society of New South Wales.

when two colleagues of Went at the University of Utrecht, Kogl and Haagen-Smit, isolated from urine in crystalline form a substance, active in causing growth curvatures, which they named auxin-a. This substance was an acid with the formula $C_{18}H_{32}O_5$ and became known as *Auxentriolic acid.* It had an activity of 50,000,000 Avena units per mg. (One Avena unit is the amount of auxin which will bring about a curvature of 10° in a decapitated Avena coleoptile.) Another active substance was shortly afterwards isolated from malt extract and corn germ oil by Kogl and co-workers and was named auxin-b. This substance was also an acid with the formula $C_{18}H_{30}O_4$ and was known as *Auxenolonic acid.* It had a similar degree of activity to auxin-a in the Avena test. In a series of brilliant researches the constitutional formulae of these two closely related compounds was elucidated by Kogl and associates, although the total amount of active crystals available was only 700 mg. The following year Kogl and co-workers isolated hetero-auxin, another physiologically active substance from urine which, on purification, was found to be identical with indole-3-acetic acid, $C_{10}H_9O_2N$, a compound which had been synthesised many years previously (1885) but had not been studied in detail.

This discovery caused a mild sensation in both botanical and chemical circles. Botanists asked themselves whether it was true that a relatively common synthetic substance like indole-acetic acid could be a plant hormone, and chemists asked whether there were any other plant hormones besides indole-acetic acid hiding away in their laboratories. Both set to work in earnest to answer these questions. Substantial evidence has now been accumulated that plants do actually contain indole-acetic acid as well as auxin-a and botanists call these substances native plant hormones, or simply auxins. From time to time there have been suggestions that other hormones occur in plants and names have, in fact, been given to certain hypothetical hormones such as rhizocaline and florigen, supposed hormones concerned with root growth and flower bud formation, but none of them has been isolated or their existence well established. It seems that all the complicated growth processes of plants, such as increase in size by cell division and enlargement, formation of roots, control of bud activity, growth of the cambium by which plants increase in girth, are controlled by the auxins. The mechanism by which this control is exercised is still imperfectly understood, and the study of the auxins and their activity within the plant is still a major study of botanists. One cannot be impressed with this relatively simple hormone equipment of plants which is in striking contrast to the elaborate system of hormone control of animals.

For their part, the chemists settled down to a thorough study of indole-acetic acid and its derivatives and compounds structurally related. Like the botanists, they used the Avena test to determine whether their new synthetics had hormonal activity but they introduced a number of other sensitive tests such as the split stem of pea test and the corn seedling test. They found that several members of the indole group of chemicals were physiologically active and this whetted interest to try other groups of chemicals. It is now known that several hundred diverse synthetic compounds can act as plant hormones although they vary widely in their degrees of activity. Of these, the most important economically are the indole derivatives and derivatives of naphthaleneacetic and phenoxyacetic acids. It is these synthetic compounds which we now call plant growth regulators. By their use it is possible to change the pattern of growth and development of plants, by speeding it here and retarding it there. When applied to

plants in appropriate ways and concentrations, and at appropriate times, plant growth regulators are able to bring about remarkable responses. They can direct or inhibit plant growth in much the same way that the native plant hormones, auxin-a and hetero-auxin do, and they can do more. If used at excessive concentrations they can stimulate a plant to such an extent that normal growth is modified and the plant burns up its food reserves and dies.

Hormones in Agriculture and Horticulture

Although several hundred synthetic chemicals are now known to have hormonal influences on plants, relatively few have yet found a place in agriculture and horticulture. In the accompanying Table are listed those that are most important. In some cases, the salts or esters are used instead of the acids. The first one—indole acetic acid is one of the most interesting because it is both an auxin, or native plant hormone, as well as a plant growth regulator, and was the chemical that set off the search for plant growth regulators. The naphthalene group has many uses. The phenoxy group provides us with selective systemic weedicides. Isopropyl phenylcarbamate is worthy of mention because of its value against weeds belonging to the grass family. Both ethylene and acetylene have been used for many years for hastening the repening of fruits although they are generally not listed as plant growth regulators. It appears logical, however, to include them in this category.

PLANT GROWTH REGULATORS AT PRESENT USED IN HORTICULTURE AND AGRICULTURE

	Common Name
Indole Group	
3-Indoleaceticacid	I.A.
3-Indolebutyricacid	I.B.
Naphthalene Group	
Alphanaphthaleneaceticacid	N.A.
Betanaphthoxyaceticacid	B.N.O.
Alphanaphthalenemethylacetate	M.e.N.A.
Phenoxy Group	
2,4-dichlorophenoxyaceticacid	2.4.D.
2-methyl 4-chlorophenoxyaceticacid	Methoxone
2,4,5-trichlorophenoxyaceticacid	T.C.P.
Miscellaneous	
Isopropyl N phenylcarbamate	I.P.P.C.
Ethylene	
Acetylene	

Rooting of Cuttings

Public interest in plant growth regulators was first aroused in 1935 when Zimmerman, Wilcoxon and Hitchcock, at the Boyce Thompson Institute for Plant Research in New York, began smearing plants with lanolin paste containing indole acetic acid, indole propionic acid and other synthetics. Within a few hours a stimulus was transmitted away from the point of application of the paste and the stem began to bend and the leaves to twist. Within ten days the stem had developed a fine crop of roots around the place of application of the smear. Earlier, Went had used a test method of estimating the concentration of auxin in plant extracts by counting the number of roots formed on cuttings of sweet pea, which had been treated with the material to be assayed.

The earliest commercial application of plant growth regulators was to promote the rooting of cuttings by speeding up the formation of callus and the initiation of roots. Most plants can be propagated from cuttings if handled appropriately and the contribution the hormones make is to shorten the process, increase the number of successful strikes and increase the number of roots. Great care of cuttings has still to be taken. The hormones are applied to the cuttings by soaking their basal ends in a very dilute solution of the chemical or dusting their ends with talc containing the chemical. Indole butryric acid is probably the most widely used chemical for rooting of cuttings but indole acetic acid and naphthalene acetic acid are also successfully used.

Rooting aids were first popularised for ornamental plants such as daphne, camellia, gardenia, etc., but more and more attention is being paid to them now in the propagation of fruit crops. The propagation of desirable varieties of fruits so that they will be true to type, calls for

THAT'S a sound tip to graziers too, for regular drenching with "Phenovis", the effective gastro-intestinal worm remedy means healthy worm-free flocks and cleaner pastures. Choice of successful graziers everywhere.

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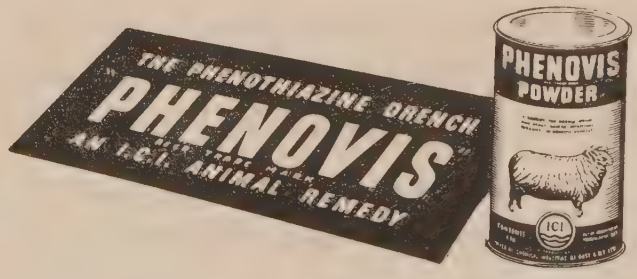
- ★ Flows easily through any drenching gun.
- ★ Ensures the most accurate dosing of stock.



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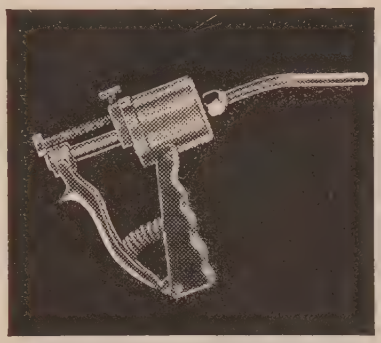

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the somewhat costly processes of budding and grafting, the desirable variety being budded or grafted on to a seedling. With some fruits it appears that it will be possible to dispense with this method with advantage and merely root cuttings of the desirable variety. Already there is a tendency to discard seedlings as rootstocks because of variation and to propagate vegetatively selected strains of rootstocks.

Setting of Fruit

Pollination of flowers is usually essential for the formation of fruit. Tomatoes grown in glasshouses in the winter often fail to pollinate their flowers because of low temperatures, insufficient light or lack of pollinating insects and crops are reduced. This was formerly overcome by selecting varieties that could withstand the cold or by hand pollinating the plants by vibrating them. Now, by spraying the trusses of flowers after they open with a dilute emulsion of β-naphthoxy-acetic acid or a mixture of indole butryric acid and β-naphthoxy-acetic acid an improved setting of fruit can be obtained. The fruit formed, of course, is seedless, but is otherwise of good quality.

Advances are still being made in formulations for tomato fruit setting and most favoured one in U.S.A. at present is an emulsion of 0.2 per cent. (2,000 ppm.) indole-butryric acid. One of the synthetic oestrogens (dihydroxy-diethyl stilbene) is also effective in setting tomatoes and has an advantage in that it does not induce undesirable formative effects in the fruit.

Improved setting of other fruits has been obtained by the use of plant growth regulators, particularly in the case of strawberries and the cultivated blackberry, both α-naphthalene-acetic acid and β-naphthoxy-acetic acid being used for this purpose.

One of the most profitable uses for plant growth regulators is to reduce the losses orchardists suffer from "windfalls" or the shedding of apples and pears just before they are ready for picking. Such losses are particularly heavy with William pears and McIntosh Red, Gravenstein and Jonathan apples. Under normal conditions the developing fruit produces sufficient hormone or auxin to retain fruit on the tree until harvest, but if the fruit is subjected to frost when young, or is exposed to hot drying winds during maturation, the natural hormone supply is reduced and separation of the abscission layer takes place. Application of a spray of dilute (5 p.p.m.) α-naphthalene-acetic acid to the fruit twelve days or so in advance of the expected harvest date generally reduces the amount of loss from pre-harvest drop.

The use of pre-harvest sprays has become, in the last year or two, a standard practice in most apple and pear growing districts of the world. Advantage of the treatment is a bigger harvest of high quality fruit with better development of colour and flavour. It also allows a better spread of picking labour. It is usual practice to drench the whole tree with the hormone spray with the object of wetting the fruit stalk but good results are being obtained in some American apple and pear orchards by applying the spray from the air. A relatively concentrated emulsion is used which the aeroplane enables to be put out as a very fine mist which floats through the orchard. Only one-third as much chemical per acre is required compared with ground application.

Hormone Weed Killers

Weed control is one of the major expense items in crop production and much of the labour of the farmer in tilling the soil is directed at killing weeds. Prior to 1940, mechanical and hand weeding were the usual methods of dealing with the weed problem and then the idea of "selective" weeding by the use of chemicals was

developed for such crops as onions and carrots. Such materials as dinitro-orthocresol and special grades of kerosene came into use, enabling the weeds to be killed without harming the onions or carrots. Then came the plant growth regulators 2,4,D and Methoxone. They had been developed independently in U.S.A. and England during the war but were kept secret until 1945. Since then they have been revolutionising farming in the temperate regions of the world by controlling weeds in grain fields and pastures. They have proved a boon, too, for weed control on golf courses and home lawns. In the wheat belt of North America the use of 2,4,D has by now become a standard practice and a recent statement has been made that the use of this chemical will result this year in an increase of more than 100 million bushels in the Canadian and U.S. wheat crops. The full value of the hormone weedicides has not yet been realised in Australia. Much organisation was necessary to secure their wide adoption in the United States of America and Canada.

The hormone weed killers 2,4,D and Methoxone are selective in their action. All grasses, including wheat, oats, barley and rye, are highly resistant to them, while many dicotyledon broad-leafed weeds are very sensitive. The chemicals are hormonal or systemic in their action, that is, they spread through the entire plant and are effective in minute amounts. They act slowly, two weeks or more may elapse before the treated plants die. Soon after application, though, the leaves begin to curl and twist, and death ensues because the food reserves of the plants become exhausted.

It has been found, further, that germinating seeds are much more sensitive to 2,4,D. than advanced seedlings and established plants. Also, in the germinating stage grasses as well as broadleaf plants are strongly affected by 2,4,D. From this is developing a method of sterilising potting soil, manure and top-dressing soil of weed seeds. A relatively low concentration of 2,4,D is used (10-100 p.p.m.). The residual effect of the chemical disappears as a result of biological action after three or four weeks if the soil or manure is kept moist and warm.

The high sensitivity of germinating seed to hormone weedicides has been used also in sterilising soil of weed seed in preparation for certain crops which are themselves sensitive to 2,4,D, and thus cannot be sprayed with a selective weedicide. Gladiolus is a crop of this type. Relatively heavy rates of 2,4,D are applied to the soil for this purpose, 5-10 lb. per acre compared with 1 lb. normally used for control of weeds in crops and pastures. The gladioli may be planted several weeks after treatment. For soil treatment the sodium or ammonium salts of 2,4,D are usually employed because of their greater solubility. A further modification is used in the case of corn. The seed is sown and after it has taken up moisture from the soil, the weedicide is applied before the corn seedlings have emerged through the soil.

Hormones in Warfare

The possible offensive value of plant growth regulators in biological warfare was examined in both England and U.S.A. during the last war. In the United States of America, for instance, the Chemical Warfare Service of the U.S. Army took up the investigation as a special project and directed the work of a number of research institutions. At Camp Detrick, in Maryland, more than one thousand substances were tested for hormonal activity against 2,4,D as a standard. The results of some of the English and American work have been published but it is not clear how hommones might be used in warfare. It is known that they are more active and persistent in oil preparations and that they

can be pelletted in water soluble waxes to aid their distribution. It is presumed they could be used for direct destruction of food crops and that planting of crops could be delayed by poisoning the soil, or irrigation waters could be contaminated with them.

In regions of high rainfall 2,4,D will disappear from the soil within a few weeks but in highly alkaline soils or in arid climates it may poison the soil for six months or more. Methoxone appears to be more persistent in the soil than 2,4,D.

Flowering Control

Considerable attention has been given to the development of a treatment that would cause delay in the opening of blossoms of peach, apricot and other stone fruits to avoid destruction of blossoms by spring frosts. If a treatment were available that would delay blossoming two or three weeks, the heavy losses which occur periodically from spring frost damage could be largely avoided. A number of plant growth regulators have been tested for this purpose and, although some delay of blooming has been obtained with sprays applied in the preceding autumn, while the flower buds are developing, the opening of leaf buds has also been retarded and sometimes the buds have been injured. The fact that some retarding effect occurs is a hopeful sign and further work with other chemicals and methods of application is proceeding.

Much loss occurs each year because of the sprouting of potatoes while in storage. Potatoes with shoots become flabby and soon are unmarketable. Sprouting, too, is undesirable if the potatoes are to be processed, e.g., chips, as the sugar content increases on sprouting and the chips turn brown when cooked. Sprouting may be held back a few months or up to one year from the date of harvesting, by treating the tubers while still fully dormant, with the methyl ester of naphthalene-acetic acid. This volatile material is applied to the potatoes by dusting them with talc or other carrier impregnated with the chemical (3.6 gm. of MeNA per lb. is sufficient for four bushels) or by mixing with the potatoes shredded paper impregnated with the ester. In certain commercial warehouses in the United States of America, the ester is applied with a spray gun as the bins are being filled through a chute.

Pineapple growers find that too many fruit ripen at the same time, making heavy demands on labour and overtaxing factory facilities. It has been found that pineapples can be made to flower and ripen at an earlier date by treatment with N.A. (5-10 p.p.m.) or 2,4,D. By spraying parts of the fields an extended harvesting period can be arranged. Plants are not sprayed until they are large enough to nourish the fruit (in the twenty to thirty leaf stage). The effect of the hormone is to change the vegetative apex into a floral apex. It is not a pollination effect, as the pineapple normally develops without pollination. Flowers become visible about seven weeks after treatment. Prior to the introduction of plant growth regulators acetylene dissolved in water had been used for many years for controlling flowering of pineapples.

The skins of stored apples often develop brown patches soon after they are removed from storage and placed on the market. The disease is known as apple scald. Some varieties of apples have been found to scald much less severely after the fruit is dipped in a lanolin emulsion containing N.A. than when untreated.

Insect Control

One of the most intriguing uses which has been found for plant growth regulators is to counteract damage to crops done by insects. The feeding of certain types of plant bugs (Lygus) on beans causes foliage injury and leads to abscission or dropping of blossoms. As a result yields

are reduced. It has been found that the application of a dust containing 40-80 p.p.m. of N.A. counteracts the feeding injury of the insect and the blossoms stay on and the yield is increased.

The spraying of citrus trees with emulsions of oil in water is a standard practice for the control of scale insects. Such sprays are very effective, but they may, however, induce leaf and fruit drop and die-back of small twigs if unfavourable weather conditions follow their application. Preliminary tests have indicated that the inclusion of plant growth regulators in oil emulsions may reduce their harmful effects on plants. This usage of hormones is, however, still undeveloped.

The field of usefulness of plant growth regulators is still expanding. The history of the development of these chemicals provides an excellent example of the economic benefits that can come from pure research. Went and Boysen-Jensen undertook their early studies on the bending of grass shoots towards light to learn the fundamentals of plant growth and in doing so they laid foundations of the greatest value to agriculture. The plant growth regulators have already won for themselves a place in agriculture alongside fertilizers, insecticides and fungicides as aids in the production of food. Around them also is developing an important chemical industry, and it should be recorded that much of our knowledge of the economic uses of these substances comes from investigations carried out with the aid of endowments provided by the chemical industry of England and the United States of America.

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ROSETTE, A VIRUS DISEASE OF THE POTATO IN TASMANIA

By E. M. HUTTON and C. E. W. OLDAKER

Introduction

The establishment of potato "seed" certification in Australia has led to a closer observation by agronomists of the occurrence of virus and virus-like diseases in the potato crop. One disease which has been seen repeatedly both in Tasmania and New South Wales is now locally known in Tasmania as "rosette." In Tasmania it has been observed in Bismark, Brownell and Up to Date (Factor) whereas in New South Wales, Orman[6] has found it only in Factor. Until recently, this disease had not been proved definitely to be virus in nature, although field observations suggested this possibility. The disease is of no economic importance in certified potato crops, and shows no evidence of increasing. It has not been observed regularly, and when found in a crop it may be confined to one site or may be distributed at random to the extent of .1 per cent. to .5 per cent of the crop. In both Tasmania and New South Wales it is not confined to any particular district, and up to the present, rosette has not been reported from the other States of Australia.

(Photograph by J. Pomeroy)

Fig. 1.

Healthy Brownell potato plant (left) and rosette infected Brownell potato plant (right), both raised in the greenhouse during midwinter from tubers collected from field-grown plants with rosette symptoms.

Irrespective of variety, infected plants in the field are dwarfed, rarely exceeding twelve inches in height, and all the leaves are curled giving a rosette appearance. Such plants are unproductive except for one or two, sometimes misshapen tubers of no commercial value.

Experimental

In February, 1947, at Henrietta, Tasmania, twenty plants with rosette were found in a small field of Brownell potatoes. The affected plants were re-

latively close together, and a tuber was taken from each plant. By mid-winter these tubers had sprouted, and were planted in the greenhouse at Canberra. Seventeen of the tubers produced normal plants which grew quickly, whereas the plants from the other three grew slowly, eventually reaching a height of ten to twelve inches. *Fig.* 1 shows the comparison between healthy and rosette plants. The stems of the infected plants tended to be thick and woody, while the leaves which were green in colour were dwarfed, the margins being crinkled and turned upwards.

One of the three plants with rosette produced a bunch of flowers at the tip, and these were pollinated with pollen from Katahdin. Six seed balls developed, and the seed extracted from them appeared quite normal. Some months later two hundred seedlings were raised from this hybrid seed and all the seedlings were healthy in appearance and free from rosette symptoms. It was apparent from this that the rosette condition was not transmitted through true seed.

All the three plants with rosette developed two to three small tubers, and when these sprouted some four months later in mid-summer, they all produced plants with rosette symptoms. The symptoms at this time of the year were different from those of mid-winter, as the infected plants, although decidedly less vigorous in growth than healthy ones, grew more rapidly and were more leafy, the leaves having a characteristic wavy appearance. This is shown in *Fig.* 2. The tuber progeny of infected Brownell plants have all produced for a further two generations plants with rosette, the symptoms varying according to the environmental conditions in the greenhouse at the time of growth. On the other hand, tuber progeny for the same number of generations from some of the healthy looking plants raised from the tubers collected from some of the rosette plants at Henrietta have always produced healthy plants. It appears that a high proportion of the rosette plants at Henrietta either did not have the disease, or were exhibiting current season symptoms, the virus not having had time to reach the

(Photograph by J. Pomeroy) **Fig. 2.**
Rosette symptoms midsummer in the greenhouse in (from left to right) Bonny Best tomato, Brownell potato and tobacco.

tubers at the time of sampling. Once the virus becomes established in the tubers, it seems to persist in all succeeding vegetative progeny. This latter fact is substantiated by the field experience with Brownell stocks at Tewkesbury Potato Research Station, Tasmania. When plants with rosette were found they were dug up, and if grown from whole seed were destroyed, but if grown from cut seed a search was made for other infected plants in the vicinity. These were usually found, and the cut setts could be fitted together to form the original parent tuber.

Transmission of the rosette condition from the Brownell potato material to healthy potatoes, tomato, tobacco and a few other hosts was attempted by hand inoculation, side and cleft grafting, and with the aphid species *Myzus persicae* (sulz.). Grafting successfully transmitted the disease in a number of instances, but all attempts with hand inoculation and aphid transmission were unsuccessful. With hand inoculation, water only, and a phosphate buffer at pH 7 containing a reducing agent, sodium sulphite, were both tried, as media in which to grind up infected material. Both long and short feeding periods (Watson and Roberts[9]) were tried with *M. persicae*. In addition, with these two latter methods transfers between all combinations of the

TABLE 1

Results of graft transmissions of the rosette disease from Brownell potato, Bonny Best tomato and tobacco

Grafted from	Grafted to	Number of Plants	Results
Brownell potato material with rosette	Tobacco	6	Definite symptoms in all grafted plants within a month—See *Fig.* 2.
	Tomato	12	
	Brownell potato	2	No current season symptoms in the grafted plants and no symptoms in the tuber progeny.
	Carman potato	2	
	Factor potato	2	
Bonny Best tomato plants with rosette (as a result of grafting with Brownell rosette)	Tobacco	6	Definite symptoms in all grafted plants within a month, as above.
	Tomato	6	
	Petunia	4	No obvious result.
	Datura stramonium	2	
	Carman potato	2	No current season symptoms. Tuber progeny of one plant typical rosette symptoms.
	Brownell potato	2	No current season symptoms in the grafted plants and no symptoms in the tuber progeny.
	Factor potato	2	
	Katahdin potato	2	
Tobacco with rosette from Brownell potato graft	Tobacco	2	Definite symptoms in all grafted plants within a month as above.
	Tomato	2	
	Petunia	2	No obvious result.
	Brownell potato	2	No current season symptoms and no symptoms in the tuber progeny.
	Carman potato	2	
	Factor potato	2	

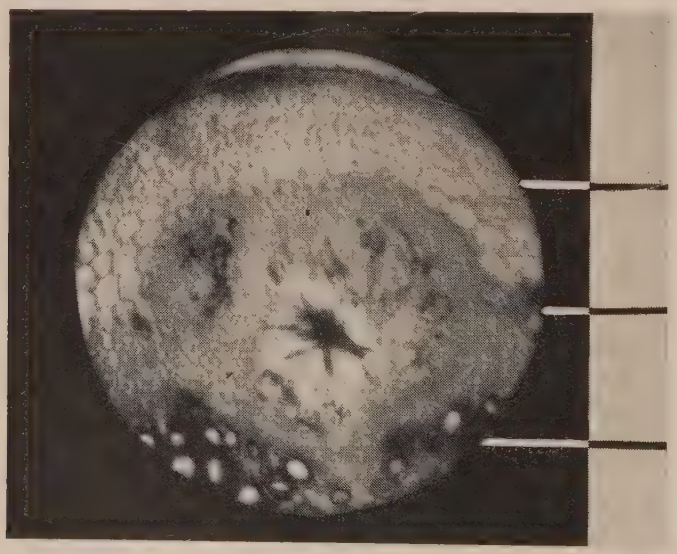
host plants used were attempted without success.

A summary of the graft transmissions which were done at various times with rosette material is given in *Table* 1.

For the transmissions shown in *Table* 1 side grafts were used, and due to the relatively small amount of Brownell rosette material stems were frequently cut into three pieces for grafting. As a separate experiment, bases of six tobacco plants left after the tops had been taken for side grafts were top grafted with healthy Brownell material and even with these, rosette symptoms did not develop in the scions.

It can be seen from *Table* 1 that the disease is readily transmitted by grafting to tomato and tobacco, but only with difficulty to potato. In only one case with Carman potato was a graft transmission successful. Insufficient work was done with other hosts like petunia and *Datura stramonium* to show the amount of transmission which could be expected. As shown in *Fig.* 2, the symptoms in tobacco and tomato are very characteristic and develop fairly rapidly. The main symptom in these hosts is a turning downwards and inwards of the leaf margins, particularly of the terminal leaves, often followed by a rolling inward of the leaf from the tip to the petiole. In tomato, the rolling up is not regular, affected leaves having a twisted-up appearance. Both these hosts retain their normal green colour and the affected leaves, mainly in tobacco, develop regular convolutions on their surfaces. These symptoms usually appear within a month from grafting, and continue for about another month, when the plants, although retarded in growth, gradually develop new growth which is dwarfed and not severely rolled and contorted. At this stage, the first rolled leaves tend to unfold.

In the early stages in infected tomato plants the disease is not unlike tomato big bud[7] although the plants flower normally. The flowers invariably absciss without forming fruit. It is possible that rosette occurs, or has occurred, as a field disease of tomatoes, as Hill[2], in November, 1937, observed a similar disease to the one described in this paper in tomato seedling beds at Eurobin, Victoria. The variety affected was San Marzano, the main



(Photograph by J. Pomeroy)

Fig. 3.

Photomicrograph (110 diams) of portion of the stem of a rosette infected Brownell potato plant. In centre a small and large hyperplastic necrotic area in the external primary phloem.

symptom being curling, wrinkling and twisting of the leaves. When this material was grafted to tobacco and potato in the greenhouse, symptoms similar to those described in this paper were obtained.

Histological changes in the stems of potato and tomato plants infected with Rosette

A modification of the technique developed by Sheffield[8] for the diagnosis of potato leaf roll was used to detect histological changes occurring in the stems of Brownell potato and Bonny Best tomato plants infected with rosette. The modification consisted in using a combination of 40 per cent. sulphuric acid (V/V) and 2 per cent. phloroglucinol (W/V) in 50 per cent. alcohol (V/V).

When transverse sections of fresh stems were treated with this combination and then examined under the microscope at a magnification of one hundred and ten diameters, hyperplastic areas almost circular in outline were observed in both the internal and external primary phloem. In each of these areas stained necrotic cells were easily discernible which tended to be arranged in almost a circular manner. *Fig.* 3 shows one small and one large hyperplastic area in the external primary phloem of a section from an infected Brownell potato stem. In *Fig.* 3, the stained necrotic areas are clearly shown, and the way in which the excessive cell development in the external primary phloem has distorted the cortical parenchyma can also be seen.

In the work of Samuel *et al*[7] on Big Bud of tomato the hyperplastic changes in the internal phloem tissue described have some similarity to the histological changes found in plants infected with rosette.

Table 2 summarises the histological observations which were made on healthy Brownell potato and Bonny Best tomato stems, six infected Brownell potato stems and two infected Bonny Best tomato stems.

As shown in *Table* 2, complete transverse stem sections were examined from the basal, mid and tip regions of the stem. In all instances where stained necrotic areas were present in infected stems, the necrosis was contained within

TABLE 2

Numbers of hyperplastic phloem areas found in complete transverse stem sections of Brownell potato and Bonny Best tomato plants infected with rosette

Material	Basal stem sections		Mid stem sections		Sections from stem tip	
	External primary phloem	Internal primary phloem	External primary phloem	Internal primary phloem	External primary phloem	Internal primary phloem
Healthy Brownell	—	—	—	—	—	—
Healthy tomato	—	—	—	—	—	—
Brownell potato with—						
rosette (1)	7	25	13	9	8	1
,, (2)	4	12	7	7	—	—
,, (3)	5	15	6	6	9	—
,, (4)	8	33	10	11	7	4
,, (5)	1	13	7	8	8	6
,, (6)	1	13	3	5	8	2
Rosette—						
tomato (1)	4	8	3	1	—	—
,, (2)	30	33	50	26	—	—

characteristic circular hyperplastic areas of primary phleom. In most instances these areas occurred in both the internal and external primary phloem and could be easily counted in the whole transverse stem section. In *Table* 2, it can be seen that the general tendency was for the stained hyperplastic areas to occur in greater numbers in the internal primary phloem than in the external primary phloem of basal sections. In mid stem sections the numbers were about equal in these two regions, whereas in stem tip sections the numbers of these areas tended to be greater in the external primary phloem than in the internal primary phloem. The numbers of areas in the infected tomato stems did not follow as regular a pattern as those found in the infected potato stems. No such areas occurred in healthy stems of potato and tomato, or in tissues other than the primary phloem of infected stems.

This finding provides another case of a virus causing necrosis confined to the primary phloem in potato, but the mode of occurrence is such that it is never likely to be confused with the necrosis caused by leaf roll[8]. Other viruses have been reported as causing phloem necrosis of potato, but in these instances the necrosis is not confined to the phloem, but is also present in other tissues. In acronecrosis of the potato, Bawden[1] found that necrosis starts in the phloem and spreads to neighbouring parenchyma and the Xylem. It has also been shown[3] that in potato plants severely affected with necrosis due to virus Y, phloem tissue, as well as cortical tissue, becomes necrosed and stains after treatment with 40 per cent. sulphuric acid and 2 per cent. phloroglucinol. In purple top wilt of potato caused by aster yellows, the phloem becomes necrotic, the necrosis spreading later to the adjacent parenchyma[4].

Comparison of Rosette with other described virus diseases of the potato

The only described potato virus disease which has a close resemblance to the rosette of Tasmania and New South Wales is that of "Green dwarf" described by Milbrath[5]. Most fields examined by Milbrath had less than one per cent. of the disease present, although it was causing some concern to certified seed growers. The main symptoms of tuber perpetuated green dwarf in the field were late emergence and extreme dwarfing. The plants were a normal green and the leaflets of young leaves were "cupped" upwards. Tubers were small but normal in appearance. In the greenhouse the symptoms described (and plate B of *Fig.* 1 for Green Mountain) in Milbrath's article closely parallel those obtained with Brownell rosette in the winter (See *Fig.* 1) at Canberra. The field symptoms observed by Milbrath generally resembled those of rosette plants found in Tasmania and New South Wales[6].

As with rosette, Milbrath was unable to transmit green dwarf with hand inoculation methods using carborundum, but did not mention experiments with insect vectors. Unlike the experiments with rosette, Milbrath was able to get a relavely high percentage of transmission by side grafting to potato, although tubers from all the plants with current season symptoms did not produce plants with green dwarf. In the Canberra experiments no current season symptoms were obtained in grafted potato plants, and only one case of tuber transmission from a grafted plant resulted. Milbrath[5] found not only a slow movement of the virus down to the tuber, but an irregular distribution of the virus within the tuber, as evidenced by the fact that sometimes only one "eye" of the tuber from an in-

fected plant would develop a green dwarf plant. Although extensive experiments were not done in Tasmania on this aspect, the evidence was that with rosette all "eyes" of infected tubers produced rosette plants.

As far as can be ascertained, the term "rosette" has not been used for any other virus disease of potatoes. It has been used to describe the disease due to *Rhizoctonia solani* in the potato, and also big bud of tomato[7]. Until positively identified with Milbrath's Green dwarf the term rosette could be retained to describe the virus disease found in Tasmania and New South Wales.

Summary

A condition occurring in Tasmanian and New South Wales potato crops, and locally known in Tasmania as rosette, has now been proved to be virus in origin by grafting experiments. It was found impossible to transfer this virus by hand inoculation and by the aphid species *M. persicae*. The disease was transmitted by grafting only with difficulty to potato, but easily to tobacco and tomato. The disease resembled most closely green dwarf, a virus disease of potato described in the United States of America. Histologically the stems of rosette plants had circular hyperplastic necrotic areas confined to the internal and external primary phloem.

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SPOTTED WILT RESISTANCE IN THE TOMATO

By E. M. HUTTON and A. R. PEAK

The spotted wilt virus has almost a world-wide distribution and causes considerable losses of tomato crops in a number of countries. As a result much effort has been expended by plant breeders to develop tomato varieties which will resist this virus. When the problem of spotted wilt resistance was investigated initially it was found that, although there were no commercial tomato varieties (*Lycopersicon esculentum*) with any marked resistance to this disease certain strains of the red currant tomato (*L. pimpinellifolium*) were highly resistant. One of the most resistant of these latter strains was that isolated by D. R. Porter, of the University of California. In the past most attempts to develop resistant varieties from crosses between *L. pimpinellifolium* and desirable commercial varieties were unsuccessful. This was probably due to a strong linkage which appears to exist between the *L. pimpinellifolium* characters and resistance, so that when selections for commercial characters are made in the progeny of such crosses, resistance is lost.

Pearl Harbour released by Kikuta *et al*[2] is the first commercial tomato variety developed to withstand spotted wilt under particular conditions. Recently Holmes[1] has discovered two Argentinian varieties, Rey de los Tempranos and Manzana, which have a high and heritable resistance to spotted wilt under New Jersey conditions. Smith[3] at the University of California confirmed the high resistance of Porter's strain of *L. pimpinellifolium* but found another wild tomato species *L. peruvianum* which appeared immune to spotted wilt under field conditions. He was able to cross this latter species with *L. esculentum* by means of an embryo culture technique. All this relatively recent work indicates that what appeared to be an insuperable problem may yet be overcome.

Under field conditions in Australia, Pearl Harbour and recently Manzana, one of Holmes'[1] accessions, have proved quite susceptible to spotted wilt. This may result from a difference in the strain complex of the virus, or from differences in virus dosage due to a greater efficiency or greater numbers of the thrips vector in Australia. Whatever the cause of this lack of resistance, the fact remains that in the greenhouse at Canberra and under epidemic conditions in the Sydney metropolitan area the high resistance of *L. peruvianum* and *L. pimpinellifolium*, particularly Porter's strain, has been confirmed a number of times. Due to the difficulties attending hybridisation between *L. peruvianum* and *L. esculentum*, it is reasonable in Australia to do more work with hybridisations between Porter's strain of *L. pimpinellifolium* and commercial varieties with the object of developing acceptable resistant varieties for our conditions. The work at Canberra has been aimed at breaking the apparent linkage between the *L. pimpinellifolium* growth characters and spotted wilt resistance.

Inoculation methods used in testing the progeny of tomato crosses for spotted wilt resistance

A virulent strain complex of the spotted wilt virus, as found in the Sydney metropolitan area, was used throughout the experiments. It was kept in an active state by hand inoculation every three to four weeks to young Bonny Best tomato plants. These usually developed marked symptoms fourteen days after inoculation, at which stage they contained a high virus concentration and were ready to be used in the preparation of inoculum. Each batch of inoculum was made by grinding in a mortar 1 gram of infected Bonny Best leaves to every 20 mls. of phosphate buffer (pH7) which contained .2 per cent. (W/V) of sodium sulphite. Hybrid progenies were inoculated in groups of 50, 20 mls. of inoculum being sufficient when at the seedling stage, but double this quantity being needed when the resistant types were inoculated at flowering and again at fruiting. After this severe testing only the most resistant types remained. Those which were susceptible at the fruiting stage almost invariably developed yellow ring spots on the ripe fruit. Resistant types at any growth stage had symptomless upper leaves from which virus could not be recovered, and showed a relatively slow development of necrosis which killed one or more of the leaflets of the inoculated leaves.

A fresh batch of inoculum was prepared for each group of fifty hybrids, and a check on its infectivity and freedom from tobacco mosaic was made before use and after the inoculation of each group by testing on leaves of *Nicotiana glutinosa*. The data for twenty-two groups of hybrids showed the mean number of spotted wilt lesions per leaf of *N. glutinosa* for all the batches of inoculum before and after inoculation of the tomato hybrids to be thirty-five and ten respectively.

Segregation for spotted wilt resistance in the progeny of two crosses having Porter's strain of *L. pimpinellifolium* as one parent

When Porter's strain of *L. pimpinellifolium* was originally tested in the greenhouse with hand inoculation methods thirty to forty per cent of the plants developed spotted wilt, possibly through admixture with seed of other strains. Seed was saved only from resistant plants to maintain the strain, and in this way its resistance was markedly increased. The first crosses were made in 1946 when flowers of the Bounty variety were crossed with pollen from the flowers of spotted wilt resistant plants of Porter's strain of *L. pimpinellifolium*. Eighty seedlings from this first generation seed were tested in the greenhouse for spotted wilt resistance and all were susceptible. The same year two backcrosses between first generation plants and the variety Sioux were made; in one Sioux was the female parent, and in the other it was the male. Segregation for spotted wilt resistance, tested in the greenhouse by hand inoculation methods, in the backcross progeny and the three succeeding generations from selfed seed of resistant plants is shown in *Table* 1.

It will be seen in *Table* 1 that the character of spotted wilt resistance is not only highly recessive, but is apparently dependent on multifactorial inheritance as the resistance is difficult to recover and is easily lost in succeeding generations. In the backcross with Sioux as the female parent, the general level of resistance tends to be lower than where Sioux is the male parent. This is probably due to the plants of the former progeny having mainly commercial tomato characters and those of the latter progeny tending more towards *L. pimpinellifolium* in type of growth. It appears from *Table* 1 that by the fourth

TABLE 1

Showing segregation of spotted wilt resistant types in two backcrosses including Porter's strain of L. pimpinellifolium, and the following selfed generations

Backcross	1st Generation		2nd Generation		3rd Generation		4th Generation	
	Number Inoculated	Number Resistant	Number Inoculated	Number Resistant	Number Inoculated	Number Resistant	Number Inoculated	Number Resistant
SX(BXPP) (S female)	405	3	(3) 47	3	(3b) 104	6	(3b2) 156	56 (36%)
							(3b6) 219	112 (51%)
					(3c) 81	2		
(BXPP)XS (S male)	220	26	(1) 33	0	(5a) 44	3		
			(4) 63	0	(5b) 4	3		
			(6) 36	0	(5c) 54	19	(5c8) 63	29 (46%)
			(7) 28	0			(5c13) 58	53 (91%)
			(5) 65	4			(5c17) 33	27 (82%)

Note: In table S = Sioux, B = Bounty, PP = Porter's strain of *L. pimpinellifolium*. Numbers in brackets refer to the resistant selections made from the progeny.

generation the spotted wilt resistance of the progeny is becoming stabilised through the process of intensive greenhouse selection which has been employed.

As stated under methods, all resistant plants shown in *Table* 1 were tested by inoculation at the seedling, flowering and fruiting periods. Pearl Harbour was used as a check variety throughout the work and almost always became a hundred per cent. infected after inoculation at the seedling stage.

Field trial of spotted wilt resistant hybrids under epidemic conditions

Through the courtesy of Mr. E. Rumsey, Managing Director of United Seed Growers Pty. Ltd., a field trial was made of the spotted wilt resistance of Pearl Harbour, Manzana from Holmes[1], *L. peruvianum, L. pimpinellifolium* (Porter's strain) and six of the hybrids developed at Canberra. These latter hybrids were some of the third generation selections shown in *Table* 1, and, although not identical with the fourth generation material tested in the greenhouse were similar to it genetically.

The trial was transplanted in early spring, 1948, four plots of each of Pearl Harbour and Manzana and two plots of each of *L. peruvianum* and *L. pimpinellifolium* being distributed at random between the single plots of each of the hybrids. The season proved ideal for the development of thrips which appeared in plague numbers so that spotted wilt occurred as an epidemic in susceptible material. As a result, many transplants were killed by spotted wilt at an early stage while the remaining plants were thoroughly inoculated with spotted wilt by the thrips. *Table* 2 summarises the results of this trial when the final inspection was made towards the end of December, 1948.

Table 2 shows that Pearl Harbour and Manzana are not resistant to an epidemic of spotted wilt in the Sydney metropolitan area. The high resistance amounting to field immunity of *L. peruvianum* and *L. pimpinellifolium* (Porter's strain) was confirmed again in this trial. The results in *Table* 2 with the hybrids, having Porter's strain of *L. pimpinellifolium* as one parent, were interesting. In these the percentage of plants which survived, although severely affected with spotted wilt, were on the average higher than with Pearl Harbour and Manzana. Where regrowth occurred in the stunted and affected plants of the varieties and hybrids, the new growth was always infected with spotted wilt.

TABLE 2

Number of plants of 2 tomato varieties, 2 species and 6 hybrids infected with spotted wilt under epidemic conditions in the Parramatta field trial

Variety, Species or Hybrid	Number transplanted September 13, 1948	Number of plants remaining December 22, 1948		
		Healthy	Recovered from spotted wilt	Stunted with severe spotted wilt
Pearl Harbour	50	—	—	10
Manzana (Holmes)	24	—	—	4
L. peruvianum	48	48	—	—
L. pimpn. (Porter's)	48	48	—	—
3b1	50	—	—	16
5a1	20	—	—	10
5b1	32	6	8	2
5c3	50	—	—	25
5c6	50	—	—	16
5c10	50	10	12	20

(Photograph by J. Pomeroy) Fig. 1.

At left fruits of Porter's strain of L. pimpinellifolium and at right fruits of hybrid derived from it and which resisted spotted wilt in the field.

The results with hybrids 5b1 and 5c10 indicate that in these particular selections the high resistance of *L. pimpinellifolium* has been retained in about twenty per cent. of the plants. In addition some twenty-five per cent. of the plants of

these hybrids apparently recovered from spotted wilt, vigorous, healthy looking regrowth being developed. This may point to a type of resistance in which the initial plant reaction has not been rapid enough to completely localise the virus under the severe epidemic conditions, but which results in the inactivation of the virus when the reduction in population of the thrips vector occurs. The high survival rate of 5c10 points to a high degree of resistance in this hybrid. *Fig.* 1 shows fruit of this hybrid in comparison with *L. pimpinellifolium* (Porter's strain) both samples being collected from the field trial. In the field trial the only plants which were fruiting at the final inspection were those of *L. pimpinellifolium* and the resistant types of hybrids 5b1 and 5c10, and in these instances fruiting was prolific. *Fig.* 1 shows that the resistant types are still not commercially acceptable, although a distinct improvement on *L. pimpinellifolium.*

When the results of *Table* 1 are examined in relation to the field resistance of these hybrids it is apparent that in the greenhouse the selections have either a medium or very high resistance, whereas in the field they have either no resistance or contain plants with a high resistance. Indications are that it is only those hybrids which have a high level of resistance in the greenhouse that are capable of exhibiting resistance in the field. In addition it is obvious that to finally develop commercial types with field resistance to spotted wilt is not going to be an easy matter. However, by a continuation of a backcrossing programme involving Porter's strain of *L. pimpinellifolium* followed by intensive greenhouse and field testing along the lines stated it is hoped that this objective will be achieved. It appears that the *L. pimpinellifolium* growth characters will have to be retained to a large degree, while increasing fruit size by backcrossing to suitable parents. By this method the linkage between resistance and growth characters in the "wild" parent may be broken.

Summary

Conditions of field infection with spotted wilt in Australia are such that Pearl Harbour and Manzana are susceptible. Porter's strain of *L. pimpinellifolium,* which is easily hybridised with commercial varieties, is field immune to this disease, but its resistance appears to be linked with its particular plant type. Work done has indicated that it may be possible to break this linkage and develop commercially acceptable types with the high resistance to spotted wilt of Porter's strain of *L. pimpinellifolium.*

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THE TREATMENT OF PEA SEED CARRYING BACTERIAL BLIGHT

By D. C. WARK

Introduction

Kreitlow[2] recommended the following seed treatments for the control of bacterial blight of beans.

(1) 1:500 mercury bichloride in diethyl ether.

(2) 1:20,000 brilliant green in 50% ethyl alcohol + 3% acetic acid.

(3) 1:500 mercury bichloride in 70% ethyl alcohol + 3% acetic acid.

(4) 1:20,000 gentian violet in 50% ethyl alcohol + 3% acetic acid.

Bacterial blight, a seed-borne disease of peas, caused by *Pseudomonas pisi*, has been serious in the Canberra district for some years. Small-scale laboratory and field tests have been conducted to determine the effectiveness of Kreitlow's and other seed treatments on reducing seed-borne infection with bacterial blight.

Laboratory Experiments

Three lines of pea seed severely contaminated with bacterial blight were used for these experiments. Samples of these lines were steeped in the bactericidal solutions for periods ranging from five minutes to twenty-four hours. Two hundred seeds of each treatment were germinated on potato dextrose agar in petri dishes which were placed in a laboratory incubator. Twenty-five seeds were germinated in each petri dish. The numbers of pea seeds with bacterial cultures growing over their surface or spreading from the pea to the potato dextrose agar were counted. The colonies were tested for pathogenicity by stab inoculations of pea pods. Those colonies giving rise to watery or oily sunken lesions within four days were classified as pathogenic. The numbers of peas out of two hundred, which showed pathogenic bacterial colonies, were recorded for each time of steeping in the various liquids. These figures are shown in *Table* 1.
pea seedlings.

The most promising treatments were those with solutions containing mercury bichloride (Solutions 1, 3, and 5), when the period of immersion of the seed exceeded twenty minutes. Immersion in these solutions for periods up to twenty-four hours did not cause any reduction in germination, which remained at one hundred per cent. in the samples tested.

Field Observation Rows

As solution 5, (1:500 mercury bichloride + 1:20,000 gentian violet in 70 per cent. ethyl alcohol + 3 per cent. acetic acid) was the most effective of those tried in the laboratory experiments, a small field observation trial was planted. Naturally contaminated seed of two varieties were treated for four hours in this solution. Three-chain rows, each containing 2400 seeds of untreated and treated seeds of these two varieties were planted in the field. Both treated and untreated seed germinated well, the variety Long Pod Alaska showing a ninety-eight per cent. germination and the variety Teton ninety-five per cent. The numbers of plants showing symptoms of bacterial blight in these rows were counted and removed until secondary spread of the disease on to the area occurred. The numbers of plants showing primary infection are shown in *Table* 2.

TABLE 1

Numbers of Pea Seed out of 200, Producing Bacterial Cultures on Agar for each time of steeping in the Different Solutions.

Time of Treatment	Seed Sample A					Seed Sample B					Seed Sample C				
	5 mins.	10 mins.	20 mins.	1 hr.	4 hrs.	24 hrs.	5 mins	10 mins.	20 mins.	1 hr.	4 hrs.	24 hrs.	5 mins	10 mins.	20 mins.	1 hr.	4 hrs.	24 hrs.
Solution 1	9	3	0	0	0	0	15	12	8	4	1	0	16	12	4	3	3	0
Solution 2	81	76	25	24	19	17	93	81	76	43	21	16	147	138	132	101	75	33
Solution 3	4	2	0	0	0	0	24	16	8	3	1	0	65	44	20	15	12	3
Solution 4	74	72	24	22	20	19	100	111	84	41	23	23	147	140	136	94	78	36
Solution 5	4	2	0	0	0	0	7	3	0	0	0	0	12	8	0	0	6	0
*Solution 6				145		24				164		24			200			26
Solution 7						34						39						43
Solution 8						31						36						39
Solution 9			16						104						176			
Untreated			136						152						198			
Surface Sterilized (bleach solution)			138						147						200			

Solution 1 = 1:500 mercury bichloride in di-ethyl ether.
Solution 2 = 1:20,000 brilliant green in 50% ethyl alcohol + 3% acetic acid.
Solution 3 = 1:500 mercury bichloride in 70% ethyl alcohol + 3% acetic acid.
Solution 4 = 1:20,000 gentian violet in 50% ethyl alcohol + 3% acetic acid.
Solution 5 = 1:500 mercury bichloride + 1:20,000 gentian violet in 70% ethyl alcohol + 3% acetic acid.
Solution 6 = 0.5% formalin.
Solution 7 = 50% ethyl alcohol + 3% acetic acid.
Solution 8 = 70% ethyl alcohol + 3% acetic acid.
Solution 9 = Hot water treatment—25 minutes at 50° C.
Surface sterilization was in bleaching powder filtrate for 10 minutes.

*Solution 6, the formalin treatment was the only treatment to seriously impair the germination, reducing it from 100% to 16% after 24 hours.

TABLE 2

Numbers of Pea Seedlings with Symptoms of Primary Infection with Bacterial Blight in a Three-Chain Row

	Untreated Seed	Treated Seed
Long Pod Alaska	45	0
Teton	80	2

It is apparent that treatment of infected pea seed with an acidified alcoholic solution of mercury bichloride and gentian violet considerably reduced the incidence of bacterial blight in the resulting

Experiments with Other Seed-borne Pathogens

Similar laboratory tests were made with other seed-borne pathogens of beans and peas.

In the case of pea seed infected with *Ascochyta pisi*, a seed-borne fungal disease, none of the treatments listed in *Table* 1 appreciably reduced the number of pea seeds which yielded *Ascochyta pisi* when germinated on agar plates.

In the cases of two seed-borne bacterial pathogens of beans (*Pseudomonas medicaginis* var. *phaseolicola*, the cause of halo blight; and *Xanthomonas phaseoli*, the cause of American or common blight), every treatment that effectively reduced the number of bean seeds giving rise to bacterial colonies also considerably reduced the germination of the bean seeds. The least harmful of the effective bacterial treatments was the steeping of the bean seed in a solution of mercury bichloride in di-ethyl ether (1:500 strength). Antibiotic substances of fungal origin may control seed-borne bacterial diseases of beans. Darpoux and Faivre-Amiot[1] have reported on the use of a culture of an Actinomycete which they have provisionally named Streptomyces 105. This fungus has a lysogenic action on many phytogenic bacteria, including the halo blight organism. Dar-

(Continued on page 41)

ERGOT OF POA ANNUA L.

By R. F. N. LANGDON

Introduction

During the winter of 1946 specimens of *Poa annua* L. (Winter grass) infected with ergot were forwarded to the author by Dr. C. J. Magee of the New South Wales Department of Agriculture. Two collections had been made at Padstow, a suburb of Sydney, one in July, the other in August. The plants in both collections were heavily infected and sclerotia had been formed in considerable numbers, particularly in the August collection. The ergot was reported to be quite abundant in a localised area at Padstow, with extremely heavy infection of individual plants. The disease was not observed in other localities around Sydney[2]. In August, 1947, the author visited the locality of the 1946 outbreak of the disease, but no infected plants were found. In a letter received from an observer at Padstow in October, 1948, it was stated that no sign of the Winter grass ergot was seen during the past winter[12].

Sclerotia obtained from aged plants germinated in November, 1946, and the ergot was determined as *Claviceps purpurea* (Fr.) Tul.

Previous Records of Ergot on Poa annua

Wilson[14], in an appendix to his paper, included *Poa annua* in a list of ergotised grasses found in Scotland, but he made no reference to that grass in the text. Wilson regarded the ergots of all the grasses he studied as *Claviceps purpurea* (Fr.) Tul. and considered that *Claviceps microcephala* (Wallr.) Tul. could not be distinguished from *C. purpurea*. Worthington Smith[15] included *Poa annua* in his list of host plants of *Claviceps purpurea* in Britain, but his record of this host for ergot was probably based on Wilson's list. Stager[11], working in Europe, concluded that an ergot of *Poa annua* which he studied was a special race of *Claviceps microcephala*. This opinion was based on infection experiments and a morphological study of the germinated sclerotia. Stager could not infect any grasses other than *Poa annua* with his strain of *Claviceps microcephala*, nor could *Poa annua* be infected with strains of *Claviceps purpurea* (including the ergot of rye) with which he worked. Although Stager considered *Claviceps purpurea* and *C. microcephala* to be distinct species, Petch[7,8], after considerable comparative study of the germinating sclerotia from many hosts, concluded that these two ergot species were the same. Mastenbroek and Oort[3] reported *Claviceps microcephala* on *Poa annua* in Holland. No other ergot infections of *Poa annua* have been reported, although many other species of Poa have been recorded as hosts of *Claviceps purpurea* in various parts of the world.

Host Relations of Claviceps purpurea

Early in the present century Stager reported that there were several strains of *Claviceps purpurea* which varied in their capacity to infect certain host plants. He found that there was one strain which infected rye and a number of cereals and grasses, a second strain infecting Brachypodium, and a third strain infecting Lolium. The Brachypodium and Lolium strains would not infect rye. Stager distinguished two other strains of *Claviceps purpurea* (known to him as *C. microcephala*), one infecting Phragmites, Aira, Molinia and Nardus, the other infecting only *Poa annua*[9,10,11]. Mastenbroek and Oort[3] have, in recent years, found another strain to which both rye and Lolium are susceptible. Padwick and Azmatullah[6] recorded *Claviceps*

purpurea on *Brachypodium sylvaticum* in India, and reported that rye and wheat were infected when inoculated with conidia of the Brachypodium ergot—results that are at variance with Stager's findings.

Inoculations with conidia from the ergot of *Poa annua* from Sydney have been made on several cereals and grasses, and though the work is not yet complete, there is evidence that the Australian strain of *Poa annua* ergot differs from Stager's European strain. Rye, skinless barley and wheat (Durum, Ford, Three Seas and Bencubbin) all give similar atypical reactions to inoculation with the *Poa annua* ergot. The ovaries are invaded by mycelium and in many cases a white paste-like coating of conidia occurs on the outer surfaces. No honeydew is produced. Sometimes a soft, dark, sclerotium-like mass of mycelium replaces the ovary, but more often the ovary remains small and becomes shrivelled. On the other hand, *Lolium rigidum* is susceptible and reacts normally, giving a typical sphacelia stage with honeydew and later forming sclerotia.

Inoculations of *Poa annua* with the rye strain of *Claviceps purpurea* have given negative results, a result which is in accordance with Stager's observations.

Discussion

The occurrence of ergot on *Poa annua* near Sydney in 1946 is the first record of *Claviceps purpurea* on *Poa annua* in Australia. Its host relations suggest that it is quite distinct from the strain of ergot found on *Poa annua* in Europe. The possibility of its introduction as a contaminant in seed imported into Australia in recent years may therefore be discounted. An alternative explanation of its occurrence may be that the *Poa annua* strain of ergot has developed from the strain or strains of *Claviceps purpurea* already in Australia *Claviceps purpurea* was introduced to Australia before the present century[4] and has persisted through the intervening years without causing serious losses. Occasionally it is reported on crop plants, e.g., a five per cent. infection of Goldthorpe Barley in Tasmania[13], and there are records of it on various grasses in Victoria[1] and New South Wales[5].

There is every indication that this ergot strain on *Poa annua* has died out, for no ergot occurred at the original site of the disease at Padstow in the years 1947 and 1948, and there have been no other reports of it. Sclerotia were produced in large numbers at Padstow in 1946, but they probably failed to survive the hot, wet summer which followed. *Claviceps purpurea* requires during its resting period in the sclerotial stage, temperatures approaching 0° C., and for its subsequent development to the ascal stage, moderate temperatures and abundant moisture. These conditions are not fulfilled in Australia for the *Poa annua* ergot. *Poa annua* is a winter growing annual which quickly disappears with the onset of warm to hot weather.

It would appear, therefore, that climatic factors have eliminated this new ergot strain, and the danger of atypical ergot infections which might occur unobserved in cereal crops has been averted.

Acknowledgments

The assistance of Dr. Lilian Fraser and Dr. C. J. Magee, of the New South Wales Department of Agriculture, who made available to me collections of the diseased plants, and Mr. H. G. Waters, who first reported the disease and later permitted me to inspect the site of the outbreak on his property, is gratefully acknowledged.

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THE TREATMENT OF PEA SEED CARRYING BACTERIAL BLIGHT

Continued from Page 38

poux and Faivre-Amiot have used Streptomyces 105 to control wildfire of tobacco, a seed-borne bacterial disease caused by *Pseudomonas tabaci.*

Conclusion

The amount of seed-borne infection of peas with bacterial blight has been considerably reduced by steeping the seed in a 1:500 solution of mercury bichloride in 70 per cent. ethyl alcohol acidified with 3 per cent. of acetic acid and with 1.20,000 gentian violet added. This treatment has little effect against a seed-borne fungal disease. Although effective against seed-borne bacterial diseases of beans, the reduction in germination of bean seed makes it an impracticable method for the control of these diseases.

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AN UNUSUAL POTATO ROT

In August, 1947, specimens of potato tubers were submitted to the Tasmanian Department of Agriculture for diagnosis of the disease present. The tubers were from a crop of Bismarks grown in the Parattah district, and the symptoms were unlike those of any of the common tuber diseases in Tasmania.

Symptoms

The affected areas were approximately circular in outline, and were sunken with the skin stretched tightly over them. *Figure* 1 shows an infected tuber with a relatively mild infection. Internally, the rotted areas were dry and powdery, with a sharp line of demarcation between the infected and diseased tissue. There was no discolouration, unless the areas had been invaded subsequently with another organism. In most cases there was a lesion of powdery scab (*Spongospora subterranea*) in the centre. If this was absent, the lesions centred around an enlarged lentical.

Etiology

An organism which produced black sclerotes, 300-500μ in diameter, and acervuli bearing conidia 20-56μ (mostly 25μ) $\times$ 4-12μ (mostly 6μ) was isolated consistently in culture. The conidia were usually biguttulate but occasionally contained up to 5 oil drops.

A culture of the organism was forwarded to the Commonwealth Mycological Institute, and was identified by Mr. E. W. Mason as *Colletotrichum atramentarium.*

To test the pathogenicity of the organism it was introduced by needle puncture into sound Bismark potato tubers. They were then placed in jars containing a free water surface, and incubated at 25° C. In four days round sunken lesions, similar to those on naturally infected tubers, developed and enlarged slowly with continued incubation. Sclerotia of the organism developed abundantly in the affected tissue.

Fig. 1.
Bismarck tuber showing natural infection with C. atramentarium through powdery scab lesions.

To determine whether an injury was necessary to establish infection, unwounded tubers were dipped in a spore suspension and incubated, but no lesions developed. It is, therefore, apparent that some form of injury is necessary for infection. In the field this usually takes the form of a powdery scab lesion, but occasionally the organism enters through enlarged lenticals induced by excessively wet conditions.

Discussion

The disease described here has only been recorded from Tasmania in one restricted locality, and it is probable that special conditions are necessary to enable the organism to cause damage. Though overseas literature contains many references to *C. atramentarium* on roots of potatoes, there are few references to its effect on tubers. Husz[1] refers to a tuber trouble of the silver scurf type, which is associated with *C. atramentarium* and Shapovalov[2] states that it is the chief secondary invader of powdery scab lesions in Pennsylvania, but he does not describe the symptoms.

Although the disease is not widespread in Tasmania, it is capable of causing severe injury if conditions favour it, and in one case over fifty per cent. of tubers from an infected area were unsaleable because of the disease.

Control of the disease would probably be best achieved indirectly, by controlling powdery scab, and avoiding areas liable to waterlogging. Crop rotation should also be practised and clean seed obtained.

G. C. WADE.

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(*Received for publication, 15th November,* 1948.)

INCREASING THE INFECTIVITY OF THE SPOTTED WILT VIRUS

When infected leaf tissue containing a plant virus, which can be transmitted mechanically, is ground up in a mortar with water the infectivity of the inoculum as shown by lesion development on an indicator plant decreases with time of standing. The rate of reduction of infectivity is rapid with viruses like spotted wilt of the tomato and relatively slow with ones like virus X of the potato. Bald and Samuel[1] showed that the addition of .1% to .2% of sodium sulphite to inoculum of the spotted wilt virus was very effective in reducing the rate of inactivation of this virus. Stanley[3] found that certain chemicals added at a concentration of 1% (W/V) to purified tobacco mosaic preparations increased infectivity when compared with untreated controls. Recently Johnson and Green[2] re-investigated Stanley's work using dilutions of 1:1000 of the various chemicals. They have listed sodium nitrate, calcium chloride, dipotassium phosphate, sodium thiosulphate and diethyl acetate in decreasing order of effectiveness when considered in relation to increasing the infectivity of tobacco mosaic virus.

It is difficult to obtain systemic invasion of potato plants by the spotted wilt virus following hand inoculations in the greenhouse. It was thought that this problem might be resolved by increasing the infectivity of the spotted wilt virus through the addition of chemicals to the inoculum. Only one of the chemicals tried, sulphanilamide, gave increased infectivity, but this increase was not sufficient to cause systemic invasion of potato plants hand inoculated with the spotted wilt virus.

TABLE 1

Table showing effect of chemical treatments on the infectivity of the spotted wilt virus

Treatments	Mean Number of localised lesions/half leaf on Nicotiana glutinosa plants	
	Inoculations made immediately after preparation of the inoculum	Inoculations made 1 hour after preparation of the inoculum
	A	B
1. Water	19.3	0
2. Sodium nitrate	49.9	0
3. Sulphanilamide	51.9	0
4. Buffer	50.3	35.3
5. Buffer, sodium nitrate	50.1	22.4
6. Buffer, sulphanilamide	84.5	12.1

Note: Statistical analysis showed results of treatments (1) and (6) of column A to be significantly different from results of treatments (2), (3), (4) and (5), between which there are no significant differences. With column B the differences between treatments (4), (5) and (6) are significant.

Table 1 summarises the results of an experiment in which the effects of sulphanilamide, sodium nitrate and buffer on the infectivity of the spotted wilt virus are compared. The two chemicals were added at the rate of 1 grm. to 1000 mls. of water in treatments (2) and (3) and at the same rate to phosphate buffer (pH7) in treatments (5) and (6). The phosphate buffer contained .2% (W/V) of sodium sulphite. For each treatment, 1 grm. of infected leaf from young tomato plants with severe spotted wilt symptoms, was ground up in 20 mls. of the appropriate solution. Three leaves of about the same maturity were inoculated on each of 16 vigorous *Nicotiana glutinosa* plants. The half leaf method was used so that each of the 6 treatments appeared at random on every *N. glutinosa* plant. The lesions were counted 7 days from inoculation.

It will be seen from the table that when the inoculations were made as soon as the inoculum was prepared, treatment (6) buffer and sulphanilamide, had the greatest infectivity, showing a considerable increase over buffer alone. In this series, treatments (2) and (3) including sodium nitrate and sulphanilamide respectively were as good as buffer when their infectivities were compared with water alone. In the second series in which the prepared inoculum was allowed to stand an hour before being used, the initial stimulating effect of sulphanilamide on infectivity was completely lost, both sodium nitrate and sulphanilamide having a depressing effect when added to buffer.

E. M. HUTTON.

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Canberra, A.C.T.

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(*Received for publication, 8th January*, 1949.)

DIGESTS

THE FUTURE OF THE AUSTRALIAN MEAT INDUSTRY

By J. L. SHUTE

The world demand for meat is greater today than ever before in history. Australia's normal yearly output is one million tons, of which three-quarters is consumed at home, leaving one-quarter of a million tons for export. The United Kingdom has asked Australia to increase her meat exports by 300,000 tons, which will necessitate a twenty-five per cent. increase in production. Before the war the United Kingdom produced 1,100,000 tons; last year, in spite of difficulties, 700,000 tons was reached. Australia is at present under contract to export all surplus meat to the United Kingdom. The present contract expires in 1950, but already extension of contract is being discussed. New Zealand and the United Kingdom recently finalised a contract under which the United Kingdom will purchase all surplus from that Dominion until 1955. Contract prices are reviewed yearly.

However, a system of trader to trader orders has been authorised by the Allied Food Council to British Protectorates, the East, Pacific Islands and West Indies. Before the war these countries drew supplies of meat from Australia and this system gives Australia an opportunity to contact her previous customers. However, these orders only amount to 35,000 tons of all classes of meat per year. But the orders are available to any country, Australian exporters have established both old and new contracts. Furthermore, in Geneva recently, arrangements were made by modifying tariffs for Australia to market meat in the United States of America, where there is a potential market for lamb. This cannot be developed until the United Kingdom contract buying scheme ends, but it is possible that token shipments will soon be permitted to determine trade practices and to establish contacts.

It would appear, therefore, that the future for our meat trade is encouraging, whereas pre-war, when the Dominions were meeting strong foreign competition, every additional pound of meat produced was an embarrassment. Conditions in South America have changed considerably, due principally to industrialisation and development of farming as opposed to grazing. In consequence there is a great reduction in the quantity of Argentine meat available to the United Kingdom, whilst Uruguay can only export limited quantities and Brazil cannot produce enough for home consumption. The Dominions, especially Australia, now have a wonderful opportunity to increase production and exports. There is available a stable market, and the question is how to take advantage of the opportunities which offer.

Australia is thus faced with four major problems, viz.:—production, transport, treatment and marketing.

Production

Immediate increases in production will be possible only from developed or partially developed areas, and if full use is made of pasture improvement and animal husbandry methods. On the East Coast of Queensland there are twenty million acres available, with regular rainfall,

(*From an address to the New South Wales Branch of the Institute on 10th December*, 1948. *Mr. J. L. Shute is Chairman of the Australian Meat Board.*)

which could be developed comparatively easily by ringbarking, provision of water supply and subdivision, provided modern equipment, manpower and materials were available. As an example of the suitability of the area for beef production, cattle pastured in a radius of 150 miles of Rockhampton represent twelve per cent. of the cattle of the Commonwealth and twenty per cent. of those of Queensland.

A long-range production plan is also envisaged. There is great scope of development in all States, particularly in Southern New South Wales, Western Victoria, Mt. Gambier district in South Australia, South-west and Kimberley District of Western Australia, Tasmania, Channel country and Gulf country of Queensland and in Northern Territory. In the Channel country only a small percentage of the feed is consumed by the cattle at present there. The Gulf country is being used mainly for breeding, though some "fats" go through to Townsville. The problem in this area and in the Territory is provision of transport for fats and stores. Many stock routes are in bad condition and rail facilities are not available. At present dams and tanks are being provided on most properties in the Gulf country and on the Berkeley Tableland so that all available feed can be used. In the Territory cattle are mostly Shorthorns, with a few Herefords. Stud bulls are bred on the spot as those imported from other States are generally not satisfactory.

Transport

Transport is one of the greatest problems of any scheme to develop the Australian meat industry; except in Victoria and Tasmania. It will be some time before railways and rolling stock can be put into pre-war condition. At the end of the war Queensland was in an especially serious position, and now, when the Meatworks are operating, it is impossible to get rolling stock to move stores, as all available trucks are carrying fats to Townsville, Rockhampton, Gladstone and Cannon Hill. In many instances stores have to be walked from Northern Territory to Queensland, New South Wales and even Victoria. Strategic railways are essential if the beef cattle industry is to be developed in Queensland, Northern Territory and the Kimberleys. During the War stock routes suffered, especially in North-western Queensland and the Territory. Strenuous efforts are being made to improve them and to establish watering facilities every ten miles. Another impediment to the beef industry is that it is not possible to move cattle until they are three years old and then, owing to the long distances, animals arrive in a muscle-bound condition and take months to recover. The Australian Meat Board realises that rail transport is the only real solution and that it cannot be established yet. In the meantime the Board is trying to improve stock routes and establish road transport from isolated areas to railheads. As an experiment, 240 cattle were moved by road transport from Anthony's Lagoon in the Territory to Alice Springs and thence 1,000 miles to Adelaide by rail. Some were killed three days and others six days after arrival. In both cases meat was very satisfactory. Cost of transport from Anthony's Lagoon to Alice Springs was £4 per head and from Alice Springs to Adelaide £3/7/- per head. This one test is not considered sufficiently conclusive to prove that road transport is economic, but the Board will carry out more experiments next season.

In the Kimberleys and North-west of Western Australia, cattle are walked 150-300 miles to the Meat Works at Wyndham and Broome. The stock routes are in bad condition and feed is often very poor. Consequently it is very difficult to move stock so that they arrive in satisfactory condition for export. The establishment

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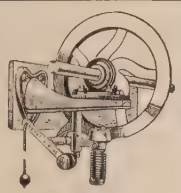

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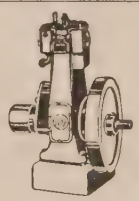

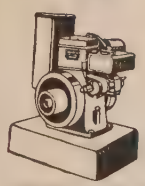

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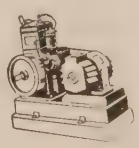

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of a railway from Wyndham South or alternatively, a bitumen road is being considered.

Treatment and marketing

In spite of the fact that Australian Meatworks are modern with good freezing facilities, none is at present working to capacity. Wyndham working ten to twelve weeks per year handles 30-40,000 head yearly. This could be doubled with little alteration to the Works. The same applies to the Queensland Works at Townsville, Rockhampton, Gladstone and Cannon Hill. As Works are closed from six to nine months each year, great difficulty is experienced in maintaining trained personnel and casual labour must be used often. The Meat Board is giving consideration to ways of spreading the killing season and in consequence to the production period, which would do much to overcome labour difficulties.

Other obstacles in developing meat production are the current high wool prices which are affecting lamb production, and the fact that increased supplies of whole milk are not being converted into butter, which makes the maintenance of pigmeat supplies difficult.

The need for uniform grade standards is obvious, a conference was held in Melbourne during 1948 at which standards for mutton and lamb were determined, and subsequently demonstrated in all States.

Shortage of manpower and supplies of essential materials have been most serious. However, supervised Aboriginal labour, when available, has proved very satisfactory, and without it many properties could not be carried on.

In anticipation of the eventual decontrol of marketing, the Meat Board is surveying all meat shipments which arrive in the United Kingdom from the viewpoint of quality and packing. Publicity is also being handled.

POST WAR SOIL SURVEYS IN SOUTH WESTERN AUSTRALIA

By R. SMITH

The Division of Soils, Council for Scientific and Industrial Research has been carrying out soil surveys in the south-west of Western Australia since early 1944. The earliest surveys were carried out at the request of the State Government following the taking of evidence by the Rural Reconstruction Commission which considered that certain districts in the higher rainfall areas were worthy of consideration for closer settlement. Early in 1944 the soil survey team, working in collaboration with the State Departments of Lands and Agriculture, carried out two small surveys of occupied land in the Margaret River District. In the summer of 1944-45, 120,000 acres of crown land on the lower Blackwood River was surveyed and in the summer of 1945-46, 45,000 acres of crown land at Rocky Gully was also covered by a soil survey. During the summer of 1946-47 the field parties were requested to carry out soil surveys of a number of estates which had been purchased for War Service Land Settlement. Six separate soil surveys, aggregating 61,000 acres, were completed in the Kojonup and Cranbrook

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(*From an address to the Western Australian Branch of the Institute on 3rd September*, 1948. *Mr. R. Smith is Regional Officer, Division of Soils, C.S.I.R.*)

districts. In the summer of 1947-48 an investigation was made of a large tract of crown land known as the Tone River and West Frankland areas. On this survey use was made of the technique of carrying out detailed or spot surveys of small representative areas, and then covering the whole district with widely spaced or reconnaissance traverses. In this way pilot areas become available for experiments and the soil pattern becomes known in a general way over large areas.

The speaker illustrated the method of compilation of detailed soil maps by reference to a soil map of 12,000 acres of land at Kojonup. Emphasis was placed on the need for thinking in terms of soil type on all research and extension projects. Description of soil types, together with chemical analyses, were presented to the meeting.

A broadscale soil map covering 950 square miles of land in the Mt. Barker district was also shown. The unit of mapping is the soil association and the map is especially suited for land planning on a fairly broad scale.

Finally, a plan for the compilation of regional soil maps to cover 100,000 square miles of south-western Australia was outlined. The mapping technique makes use of detailed or spot surveys, together with reconnaissance or soil association surveys. At the end of 30 years basic maps will be available for all agricultural land, and land planning will rest on a sure foundation.

ECONOMIC RESEARCH INTO THE SHEEP AND WOOL INDUSTRY

By P. A. REID

The basic importance of economics to agriculture generally was reviewed and the organisation which the Bureau of Agricultural Economics has set up to carry out such research was described by the speaker. As one of its activities the Bureau is responsible for economic research under the Wool Use Promotion Act and this is carried out in close co-operation with the Australian Wool Realization Commission, the Australian Wool Board, the C.S.I.R. and the State Departments of Agriculture.

The research programme is broadly divided into farm and wool growing economics and marketing economics.

Farm Economics

Three major types of field investigations are being undertaken.

1. *Regional Cost and Income Surveys*

This is the study of costs and returns, and how and why they vary. The absolute figures obtained may be inaccurate. However, the trends revealed are valid.

These surveys are being approached on a regional basis, the Australian Capital Territory and the Longreach area of Queensland at present being under investigation. The A.C.T. survey has failed to reveal any significant relation between land type and carrying capacity or gross, but the influence of pasture improvement is significant. The average

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(From an address to the Australian Capital Territory Branch of the Institute on 6th December, 1948. Mr. P. A. Reid is Principal Research Officer in the Bureau of Agricultural Economics of the Department of Commerce and Agriculture.)

area of the wool growing holdings examined was 1,926 acres with 92 per cent. under natural pasture and 6.3 per cent. improved pasture. The average stocking was 1,720 sheep and 35 cattle. On a basis of sheep enterprise the gross profit per sheep has increased from 2.3 shillings in 1944-5 to 12.5 shillings in 1946-7. At the same time average receipts per farm increased from £1,340 to £2,900. There has, however, during the same period 1944-5 to 1946-7, been a 50 per cent. rise in costs. No doubt costs have increased further during the last eighteen months and will cause embarrassment when prices recede.

The results of the Longreach survey have not yet been analysed as the field work is just being completed.

2. *Farm Management Surveys*

These have the more limited objective of measuring the economic returns of one system of management or of one particular practice of management in comparison with other systems or practices.

The first study is intended to compare the financial returns from fat lamb production with merino wool growing on improved pastures.

3. *Reconnaissance Studies*

These are rapid "fact-finding" surveys to collect essential data. These surveys, in addition to adding to the existing knowledge of the industry, will highlight special problems requiring attention.

Referring to survey procedure it was stated that good co-operation had been received from growers. Financial records have been satisfactory but physical and stock records have been very poor.

Other work on the wool growing side includes Sheep Distribution Mapping, which was carried out by Carter for New South Wales and has now been taken over by the Bureau. These maps give a rapid appreciation of the changes which have occurred in sheep population.

Marketing Research

The first major work has been the compilation of a Handbook covering the full range of sheep and wool statistics which is at present being printed. Other activities have included research into wool marketing in relation to possible development after the completion of the Joint Organization Scheme, and the continuing study of the economics of man-made fibre production and the planning of a survey of textile consumption in Australia.

A brief review was then given of the position relating to production, stocks and consumption as influencing the "Wool Outlook." The supply position, particularly of merino wools, is excellent. The short term demand for wool also appears excellent. The long term demand will be determined by the general economic conditions and the ability of wool to withstand competition from synthetics. This competition will eventually impose a price ceiling for wool and competition will be intensified on a quality/price basis. The future for wool will be influenced by the research and educational programme now being undertaken to maintain the advantage of wool over synthetics.

It was the speaker's opinion that the long-term outlook was favourable for the fine wools, but not so favourable for the coarser wools.

REVIEWS

TECHNIQUE OF BREEDING FOR DROUGHT RESISTANCE IN CROPS

By T. ASHTON

(*Technical Communication No.* 14, *Commonwealth Bureau of Plant Breeding and Genetics, Cambridge*, 1948, *pp.* 34. *Obtainable from C.A.B. Liaison Officer*, 314 *Albert Street, East Melbourne*, C.2. *Price* 3/2.)

The more important published literature relating to the complex problems of breeding for drought resistance in the principal farm crops and some grasses, is reviewed in this publication. Naturally, much of the account is devoted to wheat; and Russian sources of literature in regard to this crop are well covered. Mention is made of the *Triticum-Agropyron* hybrids—wild oats, maize, sweet corn, barley, rice and mullet, together with mixed crops; some of them tropical and sub-tropical, are only very briefly covered.

Unfortunately, grass species are considered as crops, while it is becoming increasingly recognised that drought-resistance in grasses must be considered in relation to pasture problems generally, an especially in terms of the grazing practices followed.

The communication brings out the important fact that, although water is one of the most serious factors limiting the growth of crops over very large areas, among which Australia is prominent, extraordinarily little specific breeding for drought resistance has been undertaken.

This is probably due, in the main, to the complex nature of physiological reactions to drought and hence the difficulty of securing reliable criteria or standards to work with. Simple direct measures of a morphological character, or based on osmotic pressure, transpiration, etc., have been found quite unreliable.

The more recent attempts at providing indirect indices have emphasised the use of physico-chemical characters of various kinds, but although some of these show promise for specific plants, there is no agreement as to their general value.

On the other hand, there have been some useful experiments in which pot cultures in special drought chambers have been employed and an increasing emphasis has been placed on variation of reaction to drought, according to the stage of the plant's development.

There is a bibliography of 124 references, which are appropriately referred to in the text.

H. C. TRUMBLE.

SEED PRODUCTION OF EUROPEAN VEGETABLES IN THE TROPICS

By A. G. G. HILL

(*Technical Communication No.* 19, *Commonwealth Bureau of Horticulture and Plantation Crops*, 1948, *pp.* 28. *Obtainable from the C.A.B. Liaison Officer*, 314 *Albert Street, East Melbourne*, C.2. *Price* 2/6).

When normal sources of vegetable seed supplies were cut off during the recent war, interest was focused on the possibility of producing requirements in various tropical countries, both for local needs and for the United Kingdom and other Allied Countries. East Africa was one centre of interest. In mid-1942 a scheme was launched in Kenya, Tanganyika, and Uganda, for the production of seeds of temporate region crops. The Bureau of Horticulture and Plantation Crops had earlier enquired into the methods of vegetable seed production in the tropics, and found that little was known on the subject. At the request of a Seed Conference held in East Africa in 1944, the Bureau sent a questionnaire to all tropical regions where the production of seed appeared possible, in order to collect all available information.

The replies summarised here show that in certain regions successful seed production of certain vegetables is possible. The seed, moreover, can be produced more quickly than under temperate conditions. The considerable amount of information collected is condensed in readable summary form under each main questionnaire heading. The bulletin contains useful lists of temperate vegetable varieties grown in particular tropical countries and of indigenous and naturalised tropical vegetables used in certain districts of the tropics.

In a short concluding section suggestions are made regarding profitable avenues of research, including the interrelationships of altitude, temperature, and length of day effects, and the use of tropical areas to speed up plant breeding. A wide field exists for the development of varieties suited to tropical climates.

LE CLIMAT ECOLOGIQUE DE LA CUVETTE CENTRALE CONGOLAISE

By E. BERNARD

(*Publication of the National Institute for the Study of Agronomy of the Belgian Congo*, 1945, 240 *pp.*, 36 *fig.*, 2 *maps*, 70 *tables. Price* 300 *francs. Brussels.*)

The developing interest in Australia in recent years in the problems of agricultural climatology has been paralleled by corresponding developments in Western Europe, notably in France and Belgium. In France, within the National Institute for Agricultural Research of the Ministry of Agriculture, has been established a Section of Agricultural Bioclimatology with working centres at Versailles and Montpellier. In the Belgian Congo, a climatological station has been established at Yangambi, almost on the Equator, and in 1942, E. Bernard was commissioned by the appropriate authorities to prepare a report on the climatology of this region. The publication under review is an outcome of the examination of all the data relevant to the Central Congo Basin available at that time. It is understood that further developments in the organisation of bioclimatological stations in this region have since taken place.

In Australia, as a result of the recommendations of the Rural Reconstruction Commission that an improved agro-climatological service should be established, the Commonwealth Meteorological Bureau is in process of establishing such a service within its own climatological section with special emphasis on all aspects of applied climatology, not necessarily agricultural, and with a reasonable degree of decentralisation.

The area dealt with by the author is that continental area of Africa, astride the equator, between the 16th and 26th meridians, and the 4th parallels of North and South latitudes. It is covered with an immense equatorial "shade" forest with northern and southern boundaries marginal to the tropical savannah woodlands. The greater part of the rainfall is of Atlantic origin with a mean annual precipitation ranging geographically from 60 to 90 inches.

Bernard takes as the four factors directly concerned in eco-climatology: potential evaporation, radiation, temperature, and soil moisture. He deals in turn with radiation, air and soil temperature, water vapour, precipitation and evaporation. He concludes with a discussion of the combination of these several factors in terms of climatic systems and climatic indices. He notes that for this region the climatic zones established in terms of the Koppen system are in excellent agreement with the "phytogeographic" facts.

The memoir tends to be somewhat discursive, but this leads to some very interesting discussions of general principles and the provision of some useful data of rather general interest and application, notably in the field of radiation.

Among the interesting conclusions reached is that the annual evaporation in this region from an extensive free water service is 65 inches, and that the effective evapo-transpiration from the shade forest is 55 inches. The evapo-transpiration from the Congo basin as a whole is provisionally fixed at 43 inches. The mean annual temperature is 78 deg. F., with an annual range of the order of 3 deg. F.

He also discusses at some length the possible effect of the forest on the climate and comes to the conclusion that the forest is the expression of the rainfall and has, in itself, no special effect on the climate. To an Australian worker in this field, a valuable feature of the work is a bibliography giving access to a wide range of European literature. A concluding note deals with the practice of radiation measurement with a critical discussion of the methods and instruments available from European sources.

J. A. PRESCOTT.

NEW AND PROMISING VARIETIES RECENTLY DESCRIBED IN THE LITERATURE

(*Commonwealth Bureau of Plant Breeding and Genetics*, 1948, *pp.* 44. *Obtainable from technical book shops or from the C.A.B. Liaison Officer*, 314 *Albert Street, East, Melbourne*, C.2. *Price* 3/2).

The publication presents, in tabular form, information as to agronomic characteristics, disease resistance and general adaptation of new and promising varieties of cultivated plants which have been recently described in the literature.

Wheat, oats, barley, rye, maize, sorghum, rice, herbage grasses and legumes, root, vegetable, fibre plants, sugar cane, tobacco, hops, pepper, and fruit crops are included.

The material is based almost entirely on records in vols. 15 to 17 of Plant Breeding Abstracts; references are quoted, together with the names and addresses of the institutions and organisations from which further information may be obtained.

Australia's contributions are restricted to several wheat varieties, with one flax and one cotton entry.

H. C. TRUMBLE.

ANNUAL REPORT OF COUNCIL

Report of Council to the Thirteenth General Meeting to be held at the Physics Lecture Theatre, University of Tasmania, Sandy Bay, Hobart, on 10th-11th January, 1949.

Ladies and Gentlemen;

Your Council has pleasure in presenting its report for the year ending 31st December, 1948, that is to end of the fourteenth year of Institute activity.

The office-bearers for the year were as follows:—

President: Mr. A. F. Bell.

Hon. Gen. Treasurer: Mr. F. C. McCleery.

Hon. Gen. Secretary: Dr. F. T. Bowman, succeeded by Mr. L. F. Mandelson as from 17/3/48.

Delegates:

Qld. Branch—		
	Mr. A. R. Brimblecombe.	Proxy. Mr. J. M. Vincent.
N.S.W. Branch—		
	Dr. E. T. Edwards.	
A.C.T. Branch—		
	Dr. T. H. Harrison.	Professor J. R. A. McMillan.
Vic. Branch—		
	Mr. P. T. Mitchell.	Mr. R. H. Hayman.
Tas. Branch—		
	Mr. E. F. Fricke.	Mr. R. H. Anderson.
S.A. Branch—		
	Professor H. C. Trumble.	Mr. H. P. Brown, succeeded by Mr. G. de V. Davis.
W.A. Branch—		
	Mr. G. F. Melville.	Mr. E. J. Breakwell.

Twelfth General Meeting.—The Twelfth General Meeting was held on 19th March, 1948, for the transaction of formal Institute business, namely, to receive the Reports of Council, the Editor and Business Manager of the Journal, the Statement of Accounts and Balance Sheet and the Report of Council concerning the election of President. Mr. G. de V. Davis delivered the Presidential address entitled "An End and a Beginning." The first award of the Australian Medal of Agricultural Science was made to Prof. S. M. Wadham.

Australian Medal of Agricultural Science.—Council conferred with Branches during the year in regard to conditions governing this award, and certain amendments were made.

Interchange of Personnel.—The need of freedom of interchange for scientific personnel was discussed, at Council's request, by the Joint Standing Committee of Professional Scientific Bodies. The meeting decided that, on behalf of the six professional bodies represented, an appropriate letter should be drafted and sent to the Prime Minister and Premiers. Council approved this action but arranged for the President to redraft the proposed letter to cover more explicitly its viewpoint.

To facilitate transfers from one service to another Council is arranging for similar united action through the Joint Standing Committee for negotiations with University and governmental Superannuation Boards in regard to the transfer of superannuation rights.

Salary and Status.—Arising from the resolution of the 11th General Meeting, several schedules of salaries paid to workers were received. Council recommended branches to adopt the C.S.I.R. scale of salaries and system of advancement as the basis of claims.

Improved Training in Horticulture.—During 1947, the Institute surveyed

facilities in Australia for horticultural teaching. Subsequently, the conclusions of this inquiry were brought to the notice of Universities and State Departments of Agriculture, suggesting specialised training in horticulture at University level, and that each State should provide a course leading to a Horticultural Diploma where such facilities do not already exist.

These suggestions were favourably received and some improvement in horticultural training in Australia is to be anticipated. The New South Wales Department of Agriculture proposes to establish a Diploma of Horticulture course at Hawkesbury Agricultural College as soon as practicable, and at the University of Sydney facilities now exist for a specialised course in Horticulture for students in their final year.

New Publications. — Correspondence with the Chief Executive Officer, C.S.I.R., indicated that there were difficulties in C.S.I.R. according support to the Institute in any approach to the Commonwealth Bank for finance to establish the proposed new A.I.A.S. Journal. Inquiries were subsequently addressed to the Canadian Institute of Agriculture as to the financing of their publications. The General Secretary of that Institute indicated that no actual subsidy was received from the Canadian Government, but "Scientific Agriculture" was printed free of charge by the Government Printing Bureau, other costs being met by the Institute. Their second publication, the "Agricultural Institute Review," which is published bi-monthly is financed by the advertising it carries.

Association of the Institute with A.N.Z.A.A.S. (Section K).—In accordance with Resolution 15 of the 11th General Meeting action was taken to implement arrangements for Forestry and Agriculture to become separate sections of A.N.Z.A.A.S. It has been ascertained that should this proposal be approved at a committee meeting of Section K, it goes forward to the General Council at the same meeting of A.N.Z.A.A.S. and, if then passed, may be confirmed at the subsequent General Council meeting of A.N.Z.A.A.S. two years later. Appropriate arrangements for this action have been initiated. In the meanwhile arrangements have been made for Agriculture and Forestry to have alternative programmes at A.N.Z.A.A.S. meetings.

Review of Memorandum and Articles of Association.—Branches have contributed many suggestions, and several proposed amendments to the Constitution will be considered at this meeting.

Rural Extension Services.—A proposal originating from the N.S.W. Branch for action to be taken to improve extension services throughout the Commonwealth was referred to Branches. The N.S.W. Branch is preparing a Survey and Report on this subject and other branches have been requested to examine the position in their own territories.

Requests have been made to the Commonwealth Government and to the British Council to co-operate in arranging for a visit of an English extension specialist to investigate the local position and report on methods of improvement. The suggestion was favourably received by the representative of the British Council in Australia.

Scholarships and Studentships.—In accordance with Resolution 12 from the 11th General Meeting, a Victorian Sub-Committee conducted a survey of the facilities existing in the Commonwealth for agricultural workers to proceed overseas, and have submitted a report.

The above committee also investigated Resolution 14 of the 11th General Meeting, which requested Council to initiate action designed to obtain travelling concessions and subsistence for agricultural scientists who desire to visit approved institutions in Australia during leave periods. By a majority decision Council decided to write to the Prime Minister

Summary.

Corporate Members.

BRANCH	N.S.W.	Vic.	S.A.	W.A.	Qld.	A.C.T.	Tas.	Total
Membership as at 31/12/1947	185	167	79	72	68	48	24	643
Admissions in 1948	15	15	11	—	2	4	2	49
Gains by Transfer	1	4	1	—	2	5	2	—
Losses by Transfer	5	1	2	2	2	2	1	—
Resignations	2	—	1	—	—	1	—	4
Cancellations	4	4	—	—	4	—	—	12
Deaths	—	1	—	—	—	—	—	1
As at 31/12/1948	190	180	88	70	66	54	27	675

Student Members.

BRANCH	N.S.W.	Vic.	S.A.	W.A.	Qld.	A.C.T.	Tas.	Total
Membership as at 31/12/1947	85	4	20	21	—	—	—	130
Admissions in 1948	42	7	11	—	3	—	—	63
Gains by Transfer	—	—	—	—	—	—	—	—
Losses by Transfer	—	—	—	—	—	—	—	—
Resignations	—	—	—	—	—	—	—	—
Cancellations	16	4	9	9	—	—	—	38
Deaths	1	—	—	—	—	—	—	1
As at 31/12/1948	110	7	22	12	3	—	—	154

and State Premiers setting out the views of the Institute in this connection.

U.N.E.S.C.O.—At the invitation of the Minister of Post-War Reconstruction, Council appointed Professor J. R. A. McMillan as the Institute's representative on the UNESCO National Co-operating Body of Natural Sciences.

Institute Journal.—Following the resignation of the Publications Committee early in 1948, the Victorian Branch was invited to nominate a new Committee. Accordingly, the undermentioned appointments were made:—

Hon. Editor: A. Shavitsky. *Hon. Business Manager*: W. J. Webb. *Hon. Assist. Business Manager*: P. T. Mitchell. *Committee Members*: J. A. Baker, R. D. Croll, Dr. H. C. Forster and Dr. N. S. Noble.

The printing of the Journal was transferred to Ramsay, Ware Publishing Pty. Ltd., in Melbourne, advertising being reintroduced, and an entirely new format adopted. The first edition of the Journal in its new form was No. 2 of Volume 14.

The Qualifications Committee.—This Committee, composed of Messrs *A. J. Vasey* (Convener), *J. A. Aird* and *G. W. Leeper* (succeeded by *Mr. G. H. Vasey* as from 3rd August) has continued to render considerable assistance to Council, by its investigation of all applications for membership.

Membership.—The above table shows the number of admissions, transfers and cancellations during 1948, as well as the totals for corporate and student membership as at 31st December, 1948.

Finance.—Income increased from £608 in 1947 to £755 in 1948, due wholly to an increase of £147 in receipts from subscriptions. Expenditure decreased from £578 in 1947 to £459 in 1948 and included decreases of £87 in the cost of the Journal following re-introduction of advertising matter and of £67 in expenditure on General Meetings. The initial expenditure on the Medal (cost of dies, £60) has been written off against revenue.

The excess of income over expenditure was £296 in 1948, as compared with £30 in 1947. At the end of 1948, the Accumulated Fund of the Institute amounted to £1,063.

On behalf of the Council,

A. F. BELL,
President.

THIRTEENTH GENERAL MEETING

The Report of the proceedings of the Thirteenth General Meeting of the Australian Institute of Agricultural Science, held in Hobart on January 10 and 11, 1949, will appear in the next issue of the Journal (June, 1949).

The Australian Institute of Agricultural Science

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1948.

1947.		1948.
£10 10 0	To Audit Fees	£8 8 0
90 3 0	,, Council Meeting Expenses	78 3 6
315 10 3	,, Cost of Journal	227 19 1
—	,, General Meeting Expenses	—
84 11 2	,, 12th General, Sydney	17 6 6
17 6 0	,, Legal Expenses	—
	,, Medal of Agricultural Science—	
	Cost of Dies £60 10 0	
	Cost of Medal 3 1 11	
	Travelling expenses, Medallist .. 11 1 0	
		74 12 11
22 12 1	,, Petty Cash and Incidentals	44 9 1
37 8 0	,, Printing and Stationery	7 19 0
£578 0 6	,, Total Expenditure for the Year	£458 18 1
29 17 0	,, Surplus for the Year	295 14 5
£607 17 6		£754 12 6

1947.		1948.
	By Subscriptions Received—	
£135 3 0	Vic. Branch . £179 0 0	
193 5 0	N.S.W. Branch 233 15 0	
84 0 0	S.A. Branch . 97 3 0	
58 16 0	Q'land Branch 80 6 6	
64 12 6	W.A. Branch . 82 2 0	
33 12 0	A.C.T. Branch 53 11 0	
25 9 0	Tas. Branch .. 15 15 0	
		£741 12 6
13 0 0	,, Interest Received	13 0 0
£607 17 6	,, Total Income for the Year	£754 12 6

BALANCE SHEET AS AT 31st DECEMBER, 1948.

LIABILITIES

1947.		1948.
£127 16 0	Sundry Creditors	£37 10 0
24 3 0	Subscriptions Paid in Advance	9 8 0
	Accumulated Fund—	
	Balance at 31/12/47 £767 3 9	
767 3 9	Add: Surplus for year ended 31/12/48 295 14 5	
		1062 18 2
£919 2 9		£1109 16 2

ASSETS

1947.		1948.
	Cash at Bank and in Hand	
	Sydney . £569 10 9	
	Melbourne .. 120 2 3	
£507 15 3	Petty Cash .. 8 15 8	
		£698 8 8
	Commonwealth Govt. Bonds—	
	3¼%—15/8/1956 .. 100 0 0	
	3½%—15/11/1958 . 100 0 0	
400 0 0	3¼%—15/9/1959 .. 200 0 0	
		400 0 0
11 7 6	Office Furniture	11 7 6
£919 2 9		£1109 16 2

Prudential Building,
39 Martin Place,
SYDNEY. 4th January, 1949.

The above Balance Sheet has been prepared from the Books of Account, Accounts and Vouchers of the Australian Institute of Agricultural Science and is a correct statement of the position of the Institute's affairs on the 31st December, 1948, as disclosed thereby.

HORLEY & HORLEY,
Chartered Accountants (Aust.)

ERRATA

The biographical sketch of Dr. G. L. Sutton, which appeared in the last issue of this Journal, was in no way related to his retirement, but to the award of a prize to which his name is attached.

Dr. Sutton retired in 1937 and was awarded the honorary degree of Doctor of Science in April, 1937.

THE UNIVERSITY OF SYDNEY

Research Chair in Agricultural Economics

The Senate will shortly proceed to the appointment to the newly established Research Chair in Agricultural Economics. Applications are invited for the Chair. The Professor will be required to devote his time primarily to original research in the field of Agricultural Economics. Salary will be at the rate of £1,500 per annum. There is a normal retirement provision under the Professorial Superannuation Scheme, and, in addition, a pension of £400 per annum upon retirement after attaining the age of sixty years. The Senate reserves the right to fill the Chair by invitation. A statement of conditions of appointment and information for candidates may be obtained on application to the undersigned, with whom applications close on 15th May. 1949.

G. DALE, *Registrar.*

VACANCY FOR ANIMAL HUSBANDRY ADVISER

● A vacancy exists in the British Middle East Office for an Animal Husbandry Adviser. The appointment is under the Foreign Office which will fix the pay, allowances, etc., by mutual agreement. The officer appointed will be one of a team of specialists; there are similar officers for agriculture, forestry, public health, statistics, locusts, etc. His function will be to visit various Middle East countries and give high level advice and guidance in improving and developing the livestock industry, and in all matters connected with animal husbandry generally. Professional ability of a high standard is essential and it should be coupled with as long and wide experience as possible.

● Persons interested should, in the first instance, get in touch with Professor W. L. Waterhouse, University of Sydney, N.S.W.

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